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EDITOR OF THE MONTH

ARTHUR L. WATKINS, M.D.

Boston, Massachusetts

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Postgraduate Course in Physical Medicine and Rehabilitation

UNIVERSITY OF TEXAS, MEDICAL BRANCH, GALVESTON

MARCH 1-5, 1948

PROGRAM

All meetings, unless otherwise stated, will be held in the Amphitheater, 4th floor, Outpatient Building.

Monday, March 1st —

8:00 Registration

Morning Session — Wilbur A. Selle, Chairman

9:00 Opening Remarks.....Truman G. Blocker and Chauncey D. Leake
9:15 Clinical Application of Physics and Physiology in Physical Medicine.....Arthur E. White
9:45 The Relation of Physical Medicine to Other Fields of Medicine.....Ben L. Boynton
10:10 Recess
10:20 Present Status of Fever Therapy.....H. Worley Kendell
10:50 Assistive and Supportive Apparatus in the Treatment of Muscle and Nerve Injuries.....Robert L. Bennett
11:20 Work of the Council on Physical Medicine.....Frederick A. Jung
11:50 Question Period

Afternoon Session — Edward Randall, Chairman

1:30 Instructional Period: Medical Diathermy.....Stafford L. Osborne
2:15 Fundamentals of Massage.....James B. Mennell
2:45 Question Period and Recess
3:00 Ultraviolet and Infra-red Therapy.....Richard Kovács
3:45 Progress and Future Objectives of Physical Medicine in the Veterans Administration.....A. Ray Dawson
4:15 Question Period
4:25 War Department Sound Motion Picture

Evening — Hotel Galvez — Movies

Tuesday, March 2nd —

Morning Session — Ben Boynton, Chairman

8:15 Instructional Period: Room 112 Laboratory Building, Physiological Basis of Therapeutic Heat and Cold.....Wilbur A. Selle; Local Application of Heat and Cold.....Louis P. Biro
9:00 Physiology of Normal and Atrophic Muscles and Its Application to Clinical Medicine.....Lt. Col. James E. Tate
9:30 Dynamic Physical Reconditioning.....Major Edward F. Quinn
10:00 Question Period and Recess
10:15 Manipulation of Joints of the Upper Extremity.....James B. Mennell
10:50 Occupational Therapy.....H. Worley Kendell
11:30 The Contact Splint.....George W. N. Eggers
11:50 Question Period

Afternoon Session — Oscar O. Selke, Chairman

1:30 Instructional Period: Principles of Muscle Testing and Muscle Reeducation.....Robert L. Bennett
2:15 Electrical Stimulation of Muscles.....Stafford L. Osborne
2:45 Question Period and Recess
3:00 Bulbar Cases of Poliomyelitis.....Clifford G. Grulee
3:30 The Increasing Need for Medical Rehabilitation in General Practice as Indicated by Experience of the Veterans Administration....Alvin B. C. Knudson
4:00 Unsolved Problems in Physical Medicine.....Frederick T. Jung
4:30 Question Period

Evening — Hotel Galvez — Entertainment

Wednesday, March 3rd —

Morning Session — H. Worley Kendell, Chairman

8:15 Instructional Period: Room 112, Laboratory Building, Essentials of Hydrotherapy.....Oscar O. Selke
9:00 Clinical Application and Significance of Electromyography.....Harry D. Bouman
9:30 An Ideal Treatment Program for Poliomyelitis.....Robert L. Bennett
10:30 Question Period and Recess
10:45 Ion Transfer.....Richard Kovács
11:15 Aspects of Functional Anatomy of the Lower Extremity.....Donald Duncan
11:35 Gravitational Edema.....Truman G. Blocker
11:50 Question Period

MEDICAL RESEARCH *

A. C. IVY, Ph.D., M.D., D.Sc.
Vice-President, University of Illinois
Head of the Department of Clinical Science
CHICAGO

When your President asked me to talk on the subject of Medical Research, I suspected, when I assented to do so, that I should be "carrying coals to Newcastle." On looking over the program of the Congress, I realize that such is the case. I find on the program of this Congress many men who know from first-hand experience what medical research is and how to conduct it.

Nevertheless, it is occasionally worth while for a person working in a general field to think about its general aspects. In my own research I have frequently stopped, as I call it, to "take stock," to ascertain whether I might be overlooking some "big idea" hidden in the day-to-day observations or to ascertain whether I might not be overlooking some error in the experimental design I am using. I find frequently, as does almost everyone else, that I am really doing an experiment to find out how to do the experiment properly. It is also worth while occasionally to look over a large field, a portion of which one is cultivating intensively, to ascertain whether any important ideas or correlations between data are being overlooked. In the same way it is not a waste of valuable time to exchange views on such an inclusive subject as medical research or clinical science.

The basic mundane requirements for the conduct of medical research, after the desire to conduct it actually exists, are brains, work and money. All are essential and mutually important but rarely mentioned in a discussion of medical research. I mention this simple fact because some laymen appear to believe that research can be achieved with money alone, and other laymen appear to believe that it can be done without money. I make this point also because it should be impressed on the minds of administrators and boards of trustees that to obtain a dollar's worth of salary from a faculty member he should be given an adequate research budget.

A stimulating environment is a very important but less mundane requisite for the most efficient research output. The best thing a university can do for a graduate student is to provide facilities for his work among stimulating men or with a stimulating man. This invigorating atmosphere cannot be produced artificially. It is the consequence of a zeal to extract from nature answers to questions in an environment free of prejudice except for the truth.

Persons working in the field of medical research sometimes develop the idea that it is the most important aspect of medicine. It is from the viewpoint of medical progress or progressive medicine. And, it is proper that a person should be doing work which he believes to be the most important work possible for him to do. But, history records that research is not the most important aspect from the realistic viewpoint of the uninformed layman. History records that the advance of scientific medicine has been arrested for long periods, but the practice of medicine has never been completely arrested. The practice and ethics of medicine constitute realistic indispensable needs of people. On the other hand, medical research depends on the will of an enlightened people and profession. Many people in our country today need to be enlightened on the subject of medical research, animal experimentation

* Read at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Minneapolis, Sept. 4, 1947.

and the dangers of self diagnosis and self medication. The layman must and should be continually reminded how insulin, epinephrine, digitalis, liver extract, vitamins, sulfonamides, antibiotics and other substances were discovered. It must not be forgotten that smallpox vaccination was opposed by a large section of the public and a section of the profession for years. More recently, some prominent, living pediatricians will confess that at first they opposed the use of toxin-antitoxin for diphtheria immunization.

So, medical research per se is sometimes not even the most important aspect of progressive medicine, because it might disappear entirely or its results might not be used if it were not promoted and fostered by benefactors and by an enlightened public and profession.

In this connection it is well to remember that the growth of science was not planned. It is the product of many men. That which survives does so because it meets a need. The survival of theories and classifications is directly proportional to the economy of thought and words they effect. I agree with Claude Bernard, since, as a scientist, I do not "seek for the pleasure of seeking"; I "seek the truth to possess it" — that is, to achieve with the hope that the truth I discover may fulfil a need that will directly or indirectly contribute to the conservation of health or the cure of disease.

A brief review of medical history reveals that there are two types or methods of medical research. One is the descriptive, and the other is the experimental method.

In its beginning medical research was almost entirely descriptive. Hippocrates and his school (born 460 B. C.) revolted against the superstition surrounding the cause and treatment of disease and the professional pedantry of the Cnidian school, which concealed the current ignorance of disease with a pretentious classification. By introducing the method of careful and repeated observation and case records, Hippocrates laid the foundation of modern medicine as a descriptive science.

The descriptive medical research of Hippocrates contributed two theories regarding disease which are still sound. One refers to the "healing force of nature," which teaches that when a normal process is deranged it tends to return to normal again unless the strain is too great. The other refers to the precept of the expectant treatment of disease and the requirement that the treatment should do no harm. In descriptive science, the observer reasons experimentally but does not experiment.

The method of Hippocrates is most important because of its general application. His method teaches, and its success demonstrates, that the physician or medical investigator must have an intimate and systematic knowledge of the things with which he deals and an effective way of thinking about them. It emphasizes the great importance of diligent observation of the sick person.

Before leaving this subject of the descriptive aspects of medical research, I should like to emphasize that much remains to be done in this field. The descriptive science of medicine is far from being complete. Much is to be learned about the natural history of many diseases. For example, only within very recent years have good data been available regarding the rate of recurrence of peptic ulcer. Until recent years, there were no good data on the variations in the percentage of patients who manifest a complete recovery of function in various epidemics of poliomyelitis. There are numerous gaps in knowledge similar to these. The study of the medical records of the soldiers and sailors of World War II in correlation with the diseases they manifest when they report to Veterans Hospitals in the future will contribute greatly to the knowledge of the natural history of disease. At present, in textbooks of medicine and surgery, a list of symptoms characteristic of a disease are

given, but the relative incidence of each symptom, and hence its diagnostic significance, is not given. Other defects in the quantitative aspects of medicine as a descriptive science could be mentioned. This is true of many points of diagnostic and prognostic value. In addition, a more accurate and useful nomenclature of diseases based on an understanding of the mechanism of the disease is needed. Any attempt to increase the accuracy of the definition of a disease constitutes a potent stimulus of the experimental aspects of medical research.

The experimental method of research was introduced into medicine by Galen (131-201 A. D.) in 150 A. D. The use of this method was arrested until Harvey (1578-1657) did his work on the circulation of the blood. It is important to point out that, though both of these pioneers used the analytic aspect of the experimental method, they both emphasized the wholeness of the organism.

It is of considerable interest to summarize briefly how Harvey worked as a medical investigator. He made observations on patients, studied dead bodies, experimented on man and animal and correlated his evidence to arrive at a final conclusion. To quote: "Harvey investigated the human body in health and disease, living and dead, and used animal experimentation to supplement his other studies." Since then, the expermental method has yielded all the so-called miracles of modern medicine. The entire field of therapeutics has utilized, and now utilizes, the experimental method; in fact, it is the only method for the advance of therapeutics.

Claude Bernard, in his discussion of "Experimental Medicine," has discussed at considerable length the definition of the experimental method as applied in medical research. Cuvier has said: "The observer listens to nature; the experimenter questions and forces her to unveil herself." The experimenter induces changes in the conditions of natural phenomena; he, of course, takes advantage of changes induced by disease or nature herself. At the same time, the experimenter makes judgments by comparing two facts; usually one is normal, and the other is abnormal. The important item is that one fact be compared with or used as a control against the other, so that only two facts are involved.

These requirements make medical or biologic experimentation the most difficult of all. To emphasize this presumption, I have made the statement that the problem of the atom is simpler than the problem of the living cell or organism. Much can be said in support of this presumption, but one remark may suffice: An atom does not think, though it probably has such potentialities.

The complexity of the problems of the biologist, and especially the medical scientist, accounts for the frequent unreliability of his reasoning and his interpretations. Several inherent deficiencies are well known. First, it is not always known that all the factors except one have been controlled. The introduction of a change may disturb, and frequently does disturb, more than one process. Second, even when one actually compares two factors, the extent of spontaneous variation of the two factors must be considered in the interpretation of the difference between the "normal" and "abnormal." This requires the use of statistical methods to determine whether the difference observed could be due to chance variation. Statistical reasoning is an essential tool for testing the validity of a large portion of the conclusions derived from biologic experiments. Even the more exact sciences of physics and chemistry must use the methods of statistical reasoning. Third, because of the nature of life or the organism, the isolated facts obtained on parts do not always add up to the reality observed. Very frequently, before one can correctly interpret an experimental observation, such as the production of

muscle spasm in the patient with poliomyelitis, it is necessary to know well all the parts possibly concerned and how they might react to produce the reality observed. When all the facts are known and evaluated properly, then they should add up to objective reality. Fourth, the concreteness of an observation predisposes to the fallacy of the concreteness of a conclusion. Unless we are as skeptical about our own work as we are of that of others, we are exposed to the fallacy of believing that our interpretation is as reliable as the observation. This is particularly true if sentiment is permitted to intrude itself consciously or unconsciously into the interpretation. Intuition or sentiment should be carefully labeled and separated from fact.

Devotion must attend two aspects of the use of the experimental method if the experimenter is to do his best to avoid errors. One is "the art of getting accurate facts by means of vigorous investigation"; the other is "the art of working them up by means of experimental reasoning so as to deduce knowledge of the laws of phenomena" (Claude Bernard). However, the idea is the beginning and the end of scientific endeavor, the experimental method being merely the means of truthfully joining the two. Hence in research, the mind must be kept out of a rut and free for new ideas. Doubt, necessity and curiosity are the parents of ideas and experimentation.

In physiology, which is the foundation of physical medicine, the experimental method is the chief means of progress. The big questions in physiology are: What does an organ or organism do? How does it do it? And why, or for what purpose? The truths of physiology were not derived by the method of descriptive science but had to be forcibly extracted from nature. For example, the descriptive science of Descartes placed the seat of the soul in the pineal gland.

Physiology is fundamental to medical research and the understanding and control of the manifestations of disease. Normality, regarding which much is yet to be learned, is the baseline for the study of disease. The mechanisms for normal processes are the mechanisms for disease. Symptoms represent a dislocation or cessation of normal processes. The study of symptoms and therapeutics links clinical science most closely with physiology.

If the study and practice of physiology did not transcend the study of processes operating within a normal range of activity, physiology would be sterile for both medical research and clinical science. It is the understanding and combination of the knowledge of all branches of science that have been so productive in the prevention and treatment of disease. Any knowledge, however remote, and regardless of its origin, if it bears on the conservation of health and the cure of disease, must be marshalled by clinical science and brought to the home or to the bedside.

Physical medicine is a branch of clinical science and is almost entirely an experimental science. This is because its field is almost entirely therapeutic in scope and because of its close relation to physiology. It must build on physiology, using primarily the tools of physics and chemistry. This means that men being trained for research and practice in physical medicine must be thoroughly trained in physiology, physics and chemistry. Owing to the adoption of this approach, physical medicine has made great progress in the last 20 years. It has grown from a suspect therapy into a respected branch of clinical science. The impetus and direct assistance given physical medicine by the Baruch benefaction have contributed much and will contribute a great deal more toward the development of the science of physical medicine and the service it can render in the treatment of the afflicted.

But clinical science, physical medicine, medical research and physiology are something more than applied physics and chemistry. First, they deal with living organisms which manifest the characteristics of life. Though physically

and chemically reasonable in regard to matters of energy exchange, living organisms manifest a characteristic arrangement and regulation of activities, an ability to adapt, take advantage of situations and meet contingencies which must not be neglected. Second, since the purpose of medical research or clinical science or physical medicine is to maintain health and combat disease, the study starts and ends with patients. As Galen, the first to use the experimental method in biology, taught, the patient, when being studied and treated, must be considered as a whole. Third, since clinical science in all its phases arose as the result of a human need and its research results are to be applied to patients, the attention should be kept focused on the patient — i. e., the patient should not be forgotten. Just as a clinican who studies symptoms soon becomes a physiologist, the physiologist who does research in physical medicine should soon become a clinician in interest.

During the past century the emphasis in medical research or clinical science has been placed on the prevention and treatment of acute diseases. As a result, infant and maternal mortality and death rate from many of the acute infectious diseases have been greatly reduced. Though such acute diseases as the common cold and poliomyelitis have not been conquered, the chronic diseases are the cause of most of the premature deaths and most of the days lost due to illness. Heart disease, cancer, hardening of the arteries and high blood pressure, kidney disease and tuberculosis are the leading five causes of death and kill approximately 850,000 persons in our country prematurely every year. There are a total of 21 million persons afflicted with nervous diseases, rheumatism, heart disease, hardening of arteries and high blood pressure, hay fever, asthma, tuberculosis and cancer. These diseases cause 482 million man days to be lost each year. This tremendous amount of suffering and this tremendous economic loss constitute a great challenge.

The great success which has attended the use of experimental method by clinical science renders it possible to accept this challenge of the chronic diseases and to predict that the next fifty years will witness great advances in their control.

The use of the experimental sciences makes man an inventor and gives him great control over his environment. To a large extent, he is the creator of his own destiny. Therefore, it is a privilege for anyone to have medical research as either an avocation or a vocation and to contribute directly or indirectly to the conservation of health and the treatment of disease.

STUDIES CONCERNING THE EFFECT OF DEEP TISSUE HEAT ON BLOOD FLOW *

C. R. KEMP, Ph.D.

W. D. PAUL, M.D.

and

H. M. HINES, Ph.D.

IOWA CITY

It is an axiom in physiology that the circulation of blood constitutes an effective equalizer of temperature in different parts of the body. However, it is not always clear to what extent an increase in the temperature of a given tissue can be attributed to circulatory inadequacies or to an excessive rate of tissue heating per se. Much of the information concerning the effects of heat upon tissue vascularity has been obtained from observations of the behavior of the circulation in skin and mucous membranes. There is a paucity of quantitative information concerning the effects of heat upon the vascular systems of deep tissues. The purpose of the present study was to determine the changes in tissue temperature and blood flow that result from treatments with diathermy and to determine the extent to which the degree of temperature rise is dependent upon the volume of blood flow.

Experimental Procedures

The experiments were carried out on adult dogs under pentobarbital sodium anesthesia. Blood flow was measured in the femoral artery of femoral vein by means of a bubble flow meter, as described by Dumke and Schmidt.[1] In some experiments bilateral measurements of blood flow were made simultaneously in the two limbs. This arrangement permitted one limb to serve as the experimental member and the contralateral limb as its control. Care was taken to employ cannulae of uniform bore and to insert them as high as possible in the artery or vein. Heparin was used as an anticoagulant and was administered in adequate amounts and at sufficient intervals to insure normal fluidity of the blood. Deep tissue temperatures were measured by inserting into the belly of the gastrocnemius muscles an iron-constantin junction thermocouple soldered into a No. 20 hypodermic needle. The temperature was calculated from the electromotive force registered by a Leeds and Northrup potentiometer.

Short wave diathermy was applied to the limb in dosages and with heating coil arrangements such as to produce within a twenty minute period an elevation of temperature in the gastrocnemius muscle without causing burns or other gross tissue damage. As an additional control, the operator's arm was inserted between the coils and given the same machine dosage for a period of twenty minutes without causing discomfort. In some experiments tissue heating was accomplished by the application of microwaves (2,450 megacycles) generated by a Raytheon Microtherm apparatus, as described by Krusen, Herrick and Wakim.[2]

The effects of altered circulatory patterns upon the thermogenic efficacy of diathermy was investigated in a number of animals. For this purpose one limb was subjected either to denervation or to a ligation of the femoral vein. Denervation of a limb was accomplished by sectioning the sciatic nerve at the level of the trochanter and by cutting the femoral nerve just below the ligament of Poupart. Studies were made concerning the effects of short wave diathermy upon blood flow and muscle temperature in the operated limb, and these were compared with similar studies on the

* From the Department of Physiology and the Department of Physical Medicine, College of Medicine, State University of Iowa.

* This study was made possible by a grant from the Baruch Committee on Physical Medicine in New York City.

* Read in part at the Twenty-Fourth Annual Session of the American Congress of Physical Medicine, New York, Sept. 6, 1946.

1. Dumke, P. R., and Schmidt, C. F.: Quantitative Measurements of Cerebral Blood Flow in the Macacque Monkey, Am. J. Physiol. 138:421 (Feb.) 1942.

2. Krusen, F. H.; Herrick, J. H., and Wakim, K. G.: Microkymatotherapy: Preliminary Report of Experimental Studies of the Heating Effect of Microwaves ("Radar") in Living Tissue, Proc. Staff Meet., Mayo Clinic 22:209 (May) 1947.

unoperated contralateral control limb or on the limbs of unoperated control animals.

A number of experiments were carried out for the purpose of determining the reliability and sensitivity of the method employed for measuring changes in the volume of blood flow. These included (1) measurements of the changes in blood flow associated with the application of cold; (2) changes during and after stimulation of the limb muscles with interrupted faradic current, and (3) changes induced by intra-arterial injection of either 0.5 cc. of 1:1,000,000 epinephrine solution or 50 to 100 cc. of theophylline. The vessels in limbs which had been treated with short wave diathermy were, in some instances, tested for their response to the after-effects of exercise and to the injection of theophylline. In some experiments records of arterial blood pressure and heart rate were made before and after treatments with diathermy, blood pressure being measured by use of a Hamilton manometer.

Result

Under satisfactory conditions of anesthesia the blood flow through the femoral artery tended to remain constant for a considerable period of time

TABLE 1. — *Blood Flow Through the Femoral Artery of the Dog (cc. per Minute) Control.*

Case 1 10 Minute Intervals	Case 2 5 Minute Intervals	Case 3 5 Minute Intervals	Case 4 5 Minute Intervals	Case 5 5 Minute Intervals
47	116	61	129	92
44	120	69	100	84
51	120	72	106	109
58	120	92	144	113
48	124	86	116	116
49	120	88	120	116
57	-----	67	124	116
49	-----	75	124	-----
42	-----	65	-----	-----
44	-----	69	-----	-----

(table 1). The rates of flow in the two limbs were approximately equal. The application of ice packs to a limb resulted in a lower muscle temperature and reduced blood flow through the femoral artery. The blood flow through the artery was either completely arrested or greatly decreased during the period of tetanic contraction of the muscles and was followed by a marked increase in flow during the postexercise period. The injection of epinephrine was followed by a decrease in blood flow and theophylline, by a marked increase in flow (table 2). These findings are offered as evidence that the technic employed for studying blood flow were satisfactory for demonstrating the typical responses which may occur in a number of other experimental conditions.

TABLE 2. — *Effect of Various Conditions on Blood Flow Through Normal Limbs (cc. per Minute).*

Ccondition	Control	Experimental
Cold (ice pack)	109	60
Cold (ice pack)	180	60
Muscle stimulation	95	240
Muscle stimulation	164	300
Muscle stimulation	150	240
Epinephrine injected	48	16
Epinephrine injected	69	32
Theophylline	84	360
Theophylline	45	144

The application of short wave diathermy in dosages which consistently caused a significant increase in muscle temperature during twenty minute periods of treatment failed to increase the volume of blood flow in either the femoral artery or the femoral vein of the treated limb (table 3). In many experiments a significant decrease in the volume of blood flow was

TABLE 3. — *Changes in Blood Flow in the Limb of the Dog Induced by Short Wave Diathermy Over the Gastrocnemius Muscle.*

Case	Duration, Min.	Muscle Temperature, °C. Initial	Final	Rise	Blood Flow Values (cc. per Min.) Control Average	Treatment Average	T.A./C.A. %
1	20	39.4	40.0	0.6	172.0	142.0	82.0
2	20	37.7	39.3	1.5	110.0	88.0	80.0
3	20	38.5	40.6	2.1	109.5	83.6	76.3
4	20	39.2	41.4	2.2	166.0	134.0	80.7
5	20	37.9	40.9	3.0	120.0	96.0	80.0
6	20	37.5	40.5	3.0	117.0	95.0	81.2
7	20	36.7	.....	....	113.0	120.0	106.2
8	20	37.6	.....	....	149.0	124.0	83.4
9	20	37.8	39.7	1.9	49.0	33.6	68.6
10	20	33.3	34.5	1.2	77.0	73.5	95.5
11	20	35.4	40.6	5.2	47.0	41.0	87.2
12	20	35.8	38.3	2.5	106.5	92.0	86.8
13	30	36.6	38.5	1.9	171.0	133.0	77.7
14	20	36.0	42.9	6.9	17.0	11.3	66.5
15	20	36.8	40.3	3.5	94.0	83.3	82.6
Mean	....	37.07	39.80	2.73	104.3	85.1	80.95

observed. This reduction in blood flow often occurred early in the course of the treatments and persisted for some time after the application of diathermy was discontinued. These changes occurred without any concomitant changes in arterial blood pressure and heart rate. However, it was possible during this state to demonstrate the typical responses of blood flow to the after-effects of exercise and to the administration of theophylline. No correlation existed in the individual experiments between the extent of rise in muscle temperature and the magnitude of decrease in volume and blood flow. The availability of a dog with a spinal cord transection of two weeks' duration permitted a study of the effects of diathermy upon blood flow without the use of anesthesia. In this, as in the other experiments, a rise in muscle temperature was accompanied with a reduced volume of blood flow in the femoral artery of the treated limb.

The application of standard dosages of short wave diathermy to a denervated limb causes a greater elevation in muscle temperature than is caused in the contralateral nondenervated control limb.[3] The greater efficacy of the thermogenic effects of short wave diathermy upon denervated muscle was observed both at times when the volume of blood flow was greater and at times when it was less than in control nondenervated limbs. The data (table 4) show that the application of short-wave diathermy to a denervated limb results in a decreased volume of blood flow in its femoral artery. The reduction in volume of flow was, on the average, greater than that observed in experiments on unoperated limbs.

Standard dosages of short wave diathermy applied to a limb shortly after ligation of its femoral artery caused a greater elevation in the temperature of the gastrocnemius muscle than occurred when similar treatments with diathermy were applied to control limbs. In a few experiments in which acute circulatory impairment was produced by ligating the femoral vein, it was found that the application of short wave diathermy resulted in an immediate increase in the volume of blood flow in the femoral artery. This observation suggests that the opening of venous collaterals may be facilitated by such treatments.

In contrast to the results with short wave diathermy, treatments with microwaves most frequently caused an increase in the volume of blood flow in the femoral artery or femoral vain (table 5). This fact confirms the observations of Krusen, Herrick and Wakim who found that treatments with

3. Kemp, C. R.; Tuttle, W. W., and Hines, H. M.: Studies on the Temperature Characteristics, Blood Flow and Activity in Normal and Denervated Limbs of the Dog, Am. J. Physiol. 150:705 (Oct.) 1947.

TABLE 4. — *Effects of Denervation Upon the Changes in Blood Flow Rate Induced by Short Wave Diathermy.*

Case	Denervation	Duration of Diathermy, Min.	—Muscle Temperatures, °C.— Initial	Final	Rise	—Blood Flow Values (cc. per Min.)— Control Average	Treatment Average	T.A./C.A., %
1	1 hour	20	39.2	41.2	2.0	73.0	59.6	81.6
2	1 hour	20	36.8	41.6	4.8	180.0	123.7	68.7
3	15 min.	15	38.4	37.4	—1.0	266.0	204.0	76.7
4	1 day	20	37.1	38.7	1.6	67.0	34.3	51.2
5	5 days	20	37.6	39.9	2.3	149.0	140.8	94.5
6	8 days	30	36.6	40.3	3.7	103.0	88.5	66.5
7	19 days	35	37.8	40.5	2.7	64.5	28.2	43.7
8	19 days	30	.....	.....	....	106.0	89.0	84.9
9	27 days	20	.....	.....	....	68.0	46.0	67.6
10	27 days	15	36.9	37.9	1.0	38.0	18.0	47.4
11	28 days	20	.....	.....	....	39.0	19.6	50.3
12	29 days	25	36.7	37.8	1.1	60.0	48.5	80.8
13	3 days	25	36.0	40.1	4.0	62.8	53.8	85.7
Mean	.....	....	37.3	39.5	2.2	106.3	77.9	67.7

TABLE 5. — *Effect of Microwave Energy Upon Blood Flow in the Limb of the Dog.*

Case	—Conditions of Therapy— Intensity, % †	Duration, Min.	—Muscle Temperature— Initial, °C.	Final, °C.	Blood Flow Initial	———(cc. per Min.)——— Final	Vessel
1	25–50	20	38.5	42.5	150	150	Artery
2	20	20	36.3	40.8	88	75	Artery
	40	10	40.8	42.9	75	106	Artery
	75	15	39.1	43.2	75	129	Artery
3	30	20	37.5	42.6	69	120	Artery
	30–75	25	37.8	45.3	62	109	Artery
4	20	10	37.2	42.3	37	44	Artery
	20	15	38.7	43.1	45	75	Artery
5	30–70	30	39.2	41.9	71	144	Artery
6	20–40	30	37.5	40.3	69	116	Artery
	30–80	40	38.3	41.2	73	144	Artery
	30–70	30	39.4	41.3	49	103	Artery
7*	20–16	25	37.8	42.2	67	63	Artery
8*	30	20	38.7	42.9	55	65	Artery
9*	30	20	37.1	42.8	48	78	Artery
10	30–50	30	37.8	44.7	33	55	Vein
11	30–50	50	35.9	41.5	58	82	Vein

* In denervated limb.
† Expressed as per cent of machine dosage.

microwave energy caused an increase in the blood flow through the femoral vein. The increase in blood flow following the application of microwave energy occurred concomitant with muscle temperature increases which were of the same magnitude as those observed after treatments with short wave diathermy during which either no change or a decrease in blood flow was observed. It was possible during the course of an experiment on a single animal to obtain a decrease in blood flow with short wave diathermy and later, after muscle temperature had returned to normal, an increase in blood flow during treatments with microwave energy. The order of this procedure could be reversed with similar effects of these two types of energy.

Comment

It is well to point out the limitations of the technic used to measure blood flow before attempting any analysis of the effects of deep tissue heating upon the circulatory pattern. The bubble flow meter permitted observations to be made upon the blood flow only in either the femoral artery or the femoral vein and did not give any information concerning blood flow in vessels supplied by other arteries in the limb. It was not possible to deduce

separately the blood flow in bone, connective tissue, muscle and other specialized regions supplied by the artery. Moreover, it is recognized that the procedure required general anesthesia, the use of heparin as an anticoagulant and the sectioning and cannulation of blood vessels. It is to be admitted that these conditions in themselves may effect the blood flow in the limb, and it can only be assumed that such factors operate equally during the control and experimental periods of any experiment.

The concept that in increase in temperature in any localized area of the body results in a consistent increase in blood supply and volume of circulation within the tissues of the heated region is not supported by the results of these studies. Treatments with short wave diathermy in dosages sufficient to cause a significant elevation in muscle temperature were very frequently associated with a diminished blood flow through either the femoral artery or the femoral vein of the treated limb. On the other hand, treatment of the limb with microwave energy in such a way as to cause similar degrees of temperature increase caused quite consistently an increase in the volume of blood flow. The reasons for the opposite effects upon blood flow of these two forms of energy are obscure. The findings suggest that part of the effects of these two thermogenic agents may be related to factors other than the rises in tissue temperature which they produce. The mechanism involved in the reduced blood flow in a limb during treatments with short wave diathermy appears to be of the nature of an increased peripheral resistance, inasmuch as its occurrence is not associated with any concomitant change in blood pressure and heart rate. It appears that the changes in blood flow do not involve reflex vasoconstriction or reflex vasodilatation because they were more pronounced in the experiments on denervated limbs. A suggestion is advanced that the increased peripheral resistance may be due to an increased sensitivity of the contractile elements in the blood vessels to circulating vasoconstrictor substances. The increased sensitivity may result from some unknown action of the energy applied or from the temperature changes it causes.

We can only speculate as to whether treatment of the unanesthetized patient with short wave diathermy and microwaves causes changes similar to those observed in the anesthetized animal. It is quite possible that these forms of energy when applied to spastic states of the vasomotor and skeletal systems might induce changes qualitatively and quantitatively different from those observed in these studies on the anesthetized dog. Our findings naturally raise the question as to what extent, if any, the beneficial effects of diathermy are due to vascular changes in the deep tissues. It seems possible that in some conditions at least a reduced blood flow rather than hyperemia may be the desired effect. A comparative study of the therapeutic effects of microwave energy and short wave diathermy upon the patient may answer some of these questions.

Summary

A study was made of the effects of treatments with short wave diathermy and microwave energy upon the blood flow in either the femoral artery or the femoral vein of anesthetized dogs. Short wave diathermy applied to the hindlimb of dogs in dosages adequate to produce a rise in muscle temperature failed to increase the blood flow, through the femoral artery or femoral vein of the treated limb. Frequently a significant decrease in the volume of blood flow was found to occur. Such decreases were more pronounced in experiments on denervated limbs than on normally innervated limbs and occurred independent of any changes in arterial blood pressure and heart rate. Treat-

ments with microwave energy in dosages sufficient to elevate muscle temperatures to the levels produced by short wave diathermy were in most cases accompanied by increases in blood flow.

THE EFFECT OF DIATHERMY ON BLOOD FLOW *

Plethysmographic Studies

CHARLES S. WISE, M.D.

Baruch Fellow in Physical Medicine, Harvard Medical School;
Clinical Fellow in Physical Medicine, Massachusetts General Hospital

BOSTON

Quantitative measurement of changes in blood flow produced by the modalities employed in physical medicine is essential if more effective and rational treatment is to be employed. It has been known by physiologists and clinicians that within certain limits arterial blood flow increases with elevations of the tissue temperature.[1] Paul, Kemp and Hines,[2] on the contrary, in a recent series of observations on anesthetized dogs, concluded that heating of the deep tissues by short wave diathermy resulted in diminished blood flow in the treated tissues. These conclusions would require a reevaluation of present concepts regarding tissue temperature and peripheral circulation.

This article deals with a series of observations of blood flow in the forearm of normal men before, during and after the application of diathermy. Plethysmographic recordings were made of the forearm segment heated by either condenser field or induction cable technics.

Method

Blood flow determinations were made using the venous occlusion plethysmograph similar to that described by Wilkens and Eichna[3] using a water-air system. A Brodie bellows of about 30 cc. capacity fitted with a heated nichrome wire writing point recorded volume changes on direct-writing, heat-sensitive paper. The instrument was calibrated before each set of determinations and gave a deflection of about 5 mm. on the recording paper for each cubic centimeter change in volume in the plethysmograph.

The subject was recumbent during each set of observations and the forearm segment fitted with individual rubber cuffs which were cemented to the shaved skin surface and suitably connected to the openings of the plethysmograph to form watertight seals. The rubber cuffs were supported by adjustable metal and celluloid diaphragms that fitted the forearm closely but did not constrict, forming a reasonably nondistensible box which when filled with water, as shown in chart 1, accurately reflected volume changes in the enclosed arm segment.

The wrist cuff applied distal to the plethysmograph was inflated above arterial systolic pressure thirty seconds before each determination in order to exclude the hand circulation. The blood flow was determined by suddenly inflating a cuff, placed proximal to the enclosed segment, to a pressure 30 to 40 mm. of mercury below diastolic pressure. The sudden venous occlusion caused the extremity to swell at a rate which was approximately equal to the rate of arterial inflow during the first few seconds after the

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* Read at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Minneapolis, Sept. 6, 1947.

1. (*a*) Barcroft, H., and Edholm, O. G.: Effect of Temperature on Blood Flow and Deep Temperature in Human Forearm, J. Physiol. 102:5 (June 30) 1943. (*b*) Abramson, D. I.: Vascular Responses in the Extremities of Man in Health and Disease, Chicago, University of Chicago Press, 1944, p. 92.

2. Kemp, C. R.; Paul, W. D., and Hines, H. M.: Studies Concerning the Effect of Deep Tissue Heat on Blood Flow, Arch. Phys. Med. 29:12 (Jan.) 1947.

3. Wilkins, R. W., and Eichna, L. W.: Blood Flow to Forearm and Calf; Vasomotor Reactions: Role of Sympathetic Nervous System, Bull. Johns Hopkins Hospital 68:425 (June) 1941.

venous return was stopped. After the plethysmograph was properly adjusted, the diathermy electrodes were applied in the following manner: For condenser field application, a cuff electrode was placed proximal to the plethysmograph encircling the arm just above the elbow and a pad electrode placed on the palmar surface of the hand;

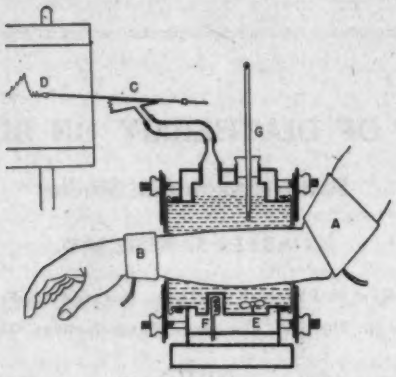

Chart 1. — Diagram of forearm plethysmograph. *A*, venous occlusion cuff; *B*, wrist cuff; *C*, recording bellows; *D*, heated wire writing point; *E*, water-circulating fan; *F*, heater; *G*, thermometer; short wave diathermy electrodes not shown.

for induction field application, a cable was placed so as to encircle the extremity two or three turns above and below the enclosed forearm segment. In all cases felt spacing pads ½ inch thick were used between the electrodes and the surface of the extremity. The water in the plethysmograph was kept relatively constant at room temperature (21 to 28 C.) in all experiments.

Ten healthy men, aged 20 to 28 years, were used. The subjects were recumbent for thirty minutes before determinations were begun. Diathermy dosage was regulated by the subjective sensation of warmth in the enclosed forearm segment in a manner similar to clinical practice. Duration of treatment varied between ten and twenty minutes, except in the first subject when excessive heating necessitated a shorter treatment period. After application of diathermy the recovery blood flow was followed for varying periods of time.

Results

In all cases there was a general increase in blood flow to the part during the exposure to either condenser field or induction cable application of diathermy. Chart 2 shows a typical result, including sample tracings made before, during and after diathermy. Chart 3 shows the results of three experiments with all the determinations plotted as a function of time, indicating the relationship of blood flow to the application of diathermy. In the table are summarized the results of the ten experiments.

Comment

Early work in the study of the circulatory effects of diathermy consisted in direct microscopic observation of tissue placed in a short wave field.[4] The workers were agreed as to the vasodilatation and increased rate of flow which was observed as the tissue was warmed. There was disagreement, however, as to the existence of any specific effect of the short waves on the blood vessels aside from thermal effects. No conclusive evidence has been presented to date of a specific effect to short waves on the blood vessels, and it can be assumed that the increased blood flow observed in the experiments here reported is a result of increased tissue temperature.

Indirect methods of measuring circulation, such as determinations of skin temperatures or thermostromuhr methods, are not feasible because of the

4. Weisz, H.; Pick, J., and Tomberg, V.: Problem of a Specific Effect of Short Waves on Blood Vessels, Arch. Phys. Therapy 19:79 (Feb.) 1938.

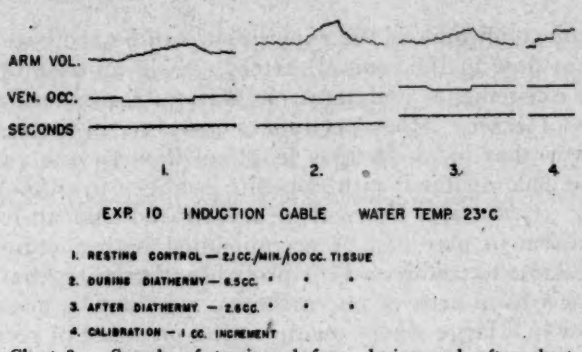

Chart 2. — Sample of tracings before, during and after short wave diathermy.

obvious technical difficulties while working in a short wave field. Paul, Kemp and Hines[2] applied diathermy to the gastrocnemius muscle of anesthetized dogs and measured blood flow in the femoral artery by means of a modified Schmidt bubble flowmeter. They observed that, despite an increase in temperature of 2 to 3 centigrade degrees in the gastrocnemius muscle, the diathermy treatments were accompanied with a reduction of blood flow through the femoral artery. From these results the authors question the beneficial effects of short wave diathermy due to vascular change in the deep tissues. They stated that "it seems quite possible that in some conditions at least a reduced blood flow rather than hyperemia may be the desired effect." This conclusion is based on the assumption that blood flow in the gastrocnemius

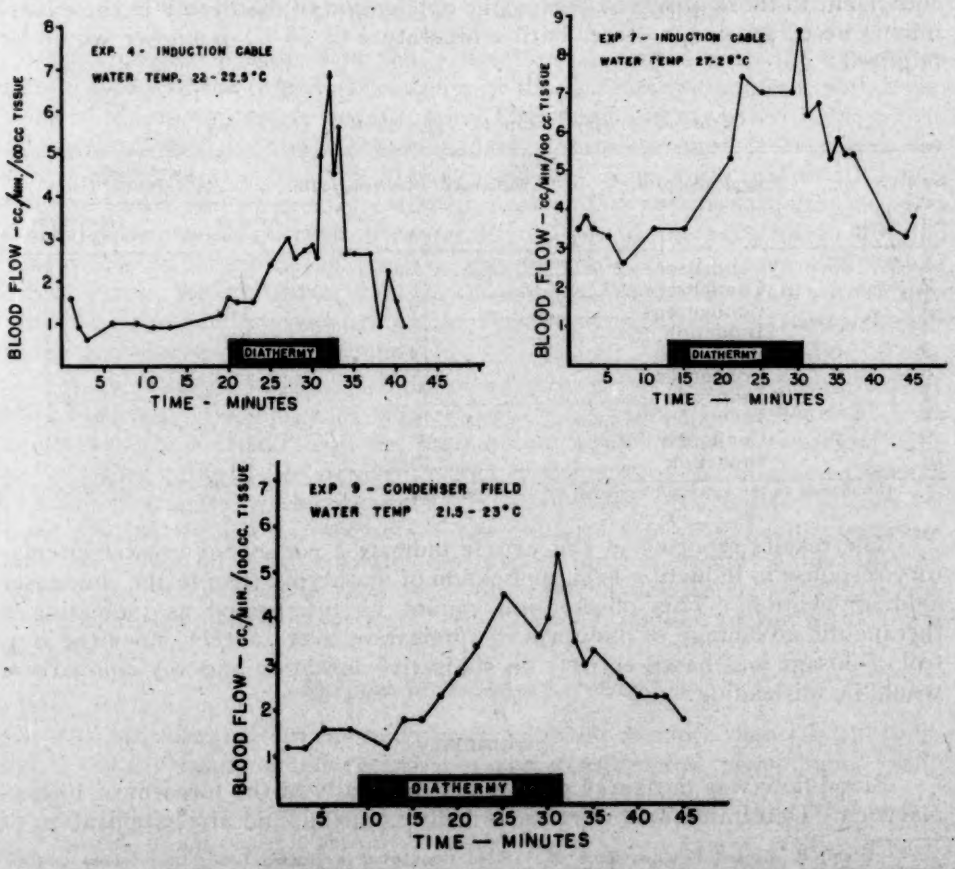

Chart 3.— Relation of blood flow to short wave diathermy; results in three experiments.

muscle under the conditions of the experiment can be accurately estimated by measurements of flow in the femoral artery. Such an assumption is open to question. The existence of collateral circulation, for example, introduces an obvious source of error. More pertinent, however, is the fact that there is evidence to show that local changes in blood flow to one portion of an extremity may be accompanied with opposite changes in other portions of the same extremity. Grant and Pearson[5] demonstrated that an increase in blood flow to the forearm in man can be accompanied with a reduction of flow in the hand of the same extremity. It is probable, therefore, that minor changes in blood flow to a local area of an extremity may not be accurately reflected in the blood flow in a large artery owing to the presence of reciprocal vascular changes in the same extremity.

The plethysmographic studies reported in this article eliminate some of these objections. The circulation was measured in the same segment of tissue as was exposed to the short wave field. The dosage was applied in a manner similar to clinical usage, and in all cases a subjective sensation of warmth was experienced by the subject. The surrounding water temperature rose less than 2.5 degrees (C.) in all cases, and frequently less than 1 degree. Evidence to show that this small rise in water temperature cannot account for the observed increase in blood flow is found in the observations reported by Barcroft and Edholm.[1a] These authors studied the resting blood flow plethysmographically in the human forearm at water bath temperatures ranging from 13 to 45 C. Between 20 and 30 C. resting blood flow remained below 2 cc. per minute per hundred cubic centimeters of tissue. To obtain resting blood flows equivalent to those observed during the application of diathermy in the experiments here reported, a water bath temperature of 35 C. or higher would be required.

Relation of Blood Flow to Application of Diathermy

Subject	Type of Application	Duration of Diathermy, Min.	Blood Flow Cc./Min./100 Cc. Tissue	
			Average Resting Control	Maximum During Diathermy
1	Condenser	7.5	5.5	11.8*
2	Condenser	15	2.8	4.9
3	Condenser	12	3.0	5.9
4	Induction	12	1.0	6.8
5	Induction	15	2.3	5.7
6	Condenser	15	1.0	2.2
7	Induction	17	3.2	8.7
8	Induction	16	2.5	5.6
9	Condenser	20	1.4	5.4
10	Induction	10	2.1	6.5

* Circulation to the hand not excluded in this experiment.

The results reported in this article indicate a somewhat greater circulatory response to induction field application of diathermy than to the condenser field application. This observation cannot be interpreted as indicating a therapeutic advantage of one form of application over another, since the control of dosage was based entirely on subjective sensation and any comparison would be misleading.

Summary

Blood flow was measured plethysmographically in the forearm of 10 normal men. Determinations were made before, during, and after application of

5. Grant, R. T., and Pearson, R. S. B.: Blood Circulation in Human Limb; Observations on Differences Between Proximal and Distal Parts and Remarks on Regulation of Body Temperature, Clin. Sci. 3:119 (April) 1938.

diathermy, by means of both condenser field and induction cable application. In all instances, an increase in circulation was found during the period of short wave heating. In contrast to previously reported observations of other workers, it is believed that some of the therapeutic effects of short wave diathermy may be the result of increased arterial blood flow.

The discussion of this paper will be published in a later issue of the ARCHIVES.

NEW DEVICES FOR DISABILITY EVALUATION *

I. Hand, Wrist, Radioulnar, Elbow and Shoulder Ergographs

F. A. HELLEBRANDT, M.D.
HELEN V. SKOWLUND, M.S.
RICHMOND, VA.
and
L. E. A. KELSO, B.S.
MADISON, WIS.

The Importance of Quantitative Methods

The devices described in this article are concerned with the evaluation of one aspect of the functional capacity of the skeletal and neuromuscular systems of the upper extremities of man. The range and diversity of the movements performed by these anatomic parts constitute one of the major distinguishing characters of the human machine. The upper extremities participate to a lesser or greater extent in nearly all occupational pursuits. Deformities, injury or disease affecting the power of the muscles to develop tension, or to transmit the tension thus developed to a strong and mobile lever system, reduce man's ability to do work. When this occurs in an employed person it may give rise to grave economic problems related to the adjudication of compensation claims.

Medical eligibility for disability compensation is usually determined by the physician. Discharge of this responsibility cannot be dissociated from analysis of the end results of the patient's total rehabilitation program. The physician is generally recognized as the best judge of the disabled patient's residual fitness for work. However, no universally accepted tests have yet been devised for the assessment of the physical fitness of healthy persons, and few valid and reliable methods of measuring the effects of disability on work capacity have found their way into clinical practice. Accordingly, reliance has been placed of necessity on the expert opinion of the medical examiner.

Purpose of the Investigation

Disability evaluation can and should be based on more than clinical judgment. Many fundamental technics of the experimental physiologist could

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* From the Baruch Center of Physical Medicine, Division of Clinical Research, Medical College of Virginia, and the Electrical Laboratory, School of Engineering, University of Wisconsin.
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be made practically applicable to disability evaluation. The object of this study in instrumentation was to apply the familiar physiologic laboratory technic of ergography to the quantitative clinical appraisal of the physical capacities of the upper extremity.

History of Ergography

The simple graphic representation of the mechanical work done when the tension produced by muscular contraction acts upon and sets into motion levers composed of articulated bones was first applied to man by the Italian physiologist Mosso. In the year 1890 Mosso,[1] Maggiora,[2] and Lombard[3] published exhaustive studies on fatigue in human muscle based on the use of the finger ergograph. The record was made with a pen carried by a little car supported on two parallel horizontal steel rods upon which the car slid. A string fastened by a leather loop to the finger pulled the car in one directon and the cord, which passed over a pulley to a weight, drew the car in the opposite direction. Thus, when the muscles contracted, the finger was flexed and the car drawn forward. When the flexors relaxed, the weight caused the finger and the car to return to their original positions. Subsequently, Franz[4] and Hough[5] introduced a spring ergograph designed to record the tension exerted during isometric contraction. This proved to be no better for the purposes intended than the weight ergograph. The classic Mosso device was then modified by Hall[6] and by Holmes[7] so that work was done only during the contractile phase of a rhythmic movement pattern. In the years which followed, instruments similar in principle to the original finger flexion device or modifications therefrom were applied to the abductor indicis,[8] and the extensor digitorum communis muscles,[9] the muscles activating the elbow joint[10] and those responsible for the squeezing action of the hand.[11] Kinard and Coleman[12] modified the technic of application, and Amar[13] used ergography in numerous ingenious ways for the purpose of industrial rehabilitation. In 1942, more than fifty years after Mosso's original discussion of ergography, Kelso commenced the modifications in design from which the devices herein described were developed.[14]

Recent Advances in Ergographic Methodology

Hough[15] early recognized the errors associated with transmitting the pulling force developed by the finger to the resisting load through the medium of the simple leather sling used by Mosso. To standardize the leverage, he introduced a splint with a hook placed at a constant distance from the

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1. Mosso, A.: Les lois de la fatigue etudiées dans les muscles de l'homme, Arch. ital de biol. 13: 123, 1890.
2. Maggiora, A.: Les lois de la fatigue etudiées dans muscles de l'homme, Arch. ital. de biol. 13: 187, 1890.
3. Lombard, Warren P.: The Effect of Fatigue on Voluntary Muscular Contraction, Am. J Psychol. 3:24 (April) 1890.
4. Franz, Shepherd Ivory: On the Methods of Estimating the Force of Voluntary Muscular Contractions and On Fatigue, Am. J. Physiol. 4:348 (Nov.) 1900.
5. Hough, Theodore: Ergographic Studies in Neuro-Muscular Fatigue, Am. J. Physiol. 5:240 (May) 1901.
6. Hall, Winfield, S.: A New Form of Ergograph, Am. J. Physiol. 6:23 (March) 1902.
7. Holmes, Jesse George: The Capacity of a Human Muscle for Work, J. A. M. A. 41:1532 (Dec.) 1903.
8. Storey, Thomas Andrew: The Influence of Fatigue Upon the Speed of Voluntary Contraction of Human Muscle, Am. J. Physiol. 8:355 (Jan.) 1903.
9. Maison, George L., and Broecker, A. G.: A Simple and Compact Ergograph for Student Use, J. Lab. & Clin. Med. 26:857 (Feb.) 1941.
10. Co Tui; Barcham, I.; Mulholland, J. H.; Kutisker, Meyer J., and Wright, Arthur Mullins: The Construction and Use of a Bedside Ergograph, Ann. Surg. 120:123 (July) 1944.
11. Lewis, Thomas; Pickering, George W., and Rothschild, Paul: Observations Upon Muscular Pain in Intermittent Claudication, Heart 15:359 (July) 1931.
12. Kinard, F. W., and Coleman, C. D.: A Modification of the Ergograph, Science 103:731, (June 21) 1946.
13. Amar, Jules: The Physiology of Industrial Organization and Reemployment for the Disabled, The Macmillan Company, New York, 1919.
14. Hellebrandt, F. A., and Skowlund, Helen V.: The Application of Ergography to Disability Evaluation: I. The Normal Fatigue Curve, Am. J. Occup. Therapy 1:73 (April) 1947.
15. Hough, T.: Certain Improvements in the Technic of Ergographic Work, Am. J. Physiol. 3:9 (March) 1901.

single joint about which rotation was permitted to occur. However, since the angle of pull changes continuously as the moving part swings in an arc during isotonic contraction, the component capable of producing rotary motion also varies continuously and it is impossible to compute by any simple means the total work done by the contracting muscle. Kelso therefore replaced the Mosso sling with a bell crank or wheel and axle. The part under study activates a bar fastened to the circumference of the wheel or an adjustable crank which is attached to the axle. As the test load is lifted, the wheel turns and the contact bar or crank moves in an arc. Thus, the angle at which resistance is exerted remains constant throughout the full range of movement. This is especially important in the study of disabled joints in which limited motion may occur within a range which is mechanically disadvantageous when tested by the original technic.

The principal features of the method are illustrated in chart 1. The cumulative height of successive lifts is indicated in centimeters by a distance meter while being simultaneously recorded by an ink-writing capillary pen on the drum of a slowly revolving kymograph. An electromagnetic signal indicates the total number of contractions. Time is recorded in any desired interval by a simple mechanical chronograph driven by a 6 R.P.M. synchronous motor. There are no overhanging parts. The load moves in a tower on a carrier traveling with minimal friction on two vertical rods. The lifting force is transmitted from the bell crank to the power sprocket and through a chain over a secondary wheel and axle to the carrier which supports the load. Mounted on the axle of the secondary sprocket are two wheels of different radii from either of which the stroke-recording pen may be suspended by a linen thread. Thus, the height of the lift may be variously reduced for convenience in recording.

The ergograph illustrated was designed to measure the work capacity of muscle groups eliciting flexion or extension of the wrist joint. A crank with a vertical hand-grasp is used for studying abduction or adduction with the forearm in midposition between pronation and supination. The two handles are interchangeable, are adjustable in length and may be set to permit motion to begin at any point in the arc of joint range. Thus, the instrument may be used in the presence of deformity in anatomic alinement. An auxiliary arm plate can readily convert the wrist ergograph to a finger ergograph, applicable to exercise of individual digits or of all four fingers in unison. As now constructed, the same instrument cannot be used for both the right and the left extremity. An ergometer built on exactly the same principle has been designed for normal range exercise of the elbow and shoulder joints. It is sturdier in construction and rests on a heavy platform, adjustable as to height, mounted on casters and stabilized with set screws during use. The applications of ergography to the squeezing action of the hand and to the thumb involve special features. These will be described separately.

The radioulnar ergograph is illustrated in chart 2. The hand grasps a hand-hold attached at right angles to an axle which activates two power sprockets connected by chains passing over two secondary sprockets to the load carrier through a single pulley fixed to the central rod of the carrier by a stiff spring. A specially designed table permits the device to be used by either arm. When used by the right arm, one power sprocket moves clockwise on supination; the other turns counterclockwise on pronation. The movements are reversed when the contralateral limb is employed. The hand-hold may be adjusted to permit resistive action in either direction from a neutral starting position or at points deviating from this by 45 or 90 degrees. The cumulative height of successive lifts is indicated in centimeters by separate distance meters for pronation and for supination. Separate electromagnetic signals indicate the number of lifts in pronation and supination. As illustrated in chart 3, the recording pen travels upward from a common baseline with one movement and downward with the other. The patient may perform repetitive exercise against graded resistance in supination or pronation or may do both movements alternately.

In the use of the hand, wrist and radioulnar ergographs, the subject is seated on a stool adjustable in height with shoulders even and forearm supported on a padded arm rest. If the feet are not flat on the floor, a foot stool is provided. The forearm is held in place by adjustable straps as needed. Initial training under careful supervision is necessary to minimize accessory movements. The proper coordination is quickly gained by practice. The elbow and shoulder ergograph may be used with the patient in recumbency, sitting or standing.

Technic of Application

Both the testing and the exercise procedure consist in brief work bouts with intervening rest periods. The character of the ergographic fatigue curve

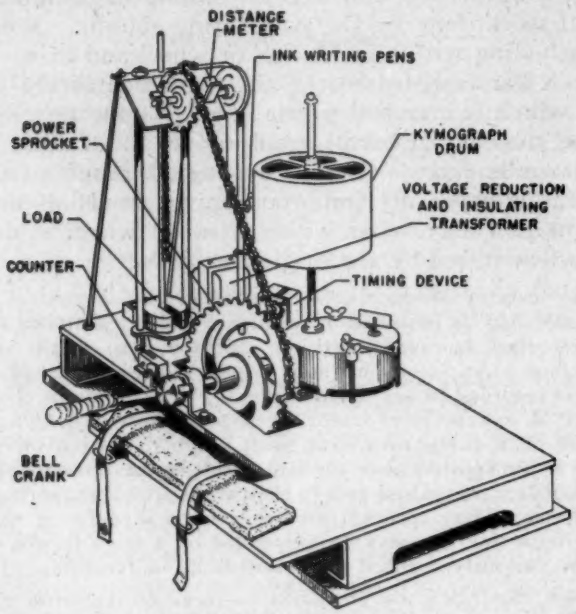

Chart 1. — Ergograph for study of the functional capacity of the flexors and extensors of the right wrist. A bell crank with a vertical handle is used for the study of the abductors and adductors. The chain is attached as illustrated at 3 o'clock on the power sprocket when the extensors and abductors are exercised. The sprocket then moves clockwise. For the study of flexion and adduction, the chain is attached at 9 o'clock and the sprocket moves counterclockwise.

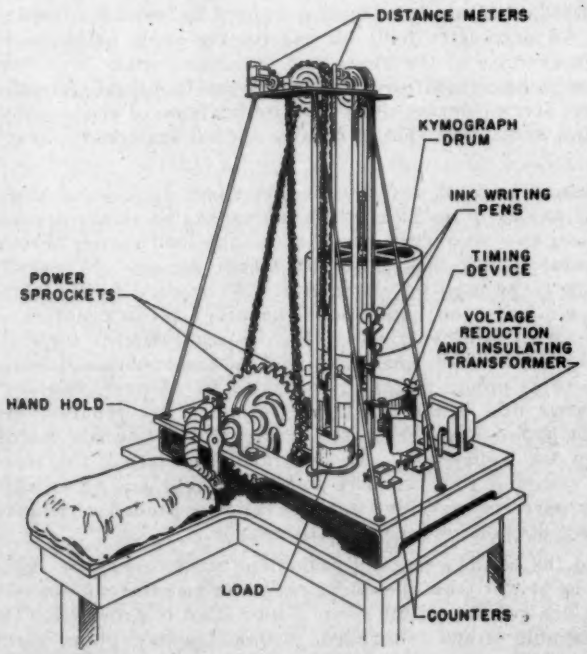

Chart 2. — Radioulnar ergograph for the study of pronation and supination.

indicates the severity of the effort. The steeper the slope gradient of the fatigue curve, the heavier the work. Light exercise is characterized by the establishment of a fatigue level which may be maintained indefinitely, as the muscles work aerobically, well within their steady state capacity. Ex-

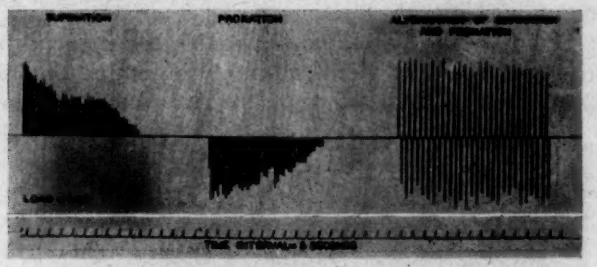

Chart 3. — Illustrative ergograms showing the registration of pronation and supination, either individually or alternately, against a load of 3.25 Kg.

ercise of this type is useful for mobilizing joints, stimulating the circulation and augmenting work tolerance but it has limited value when the objective of treatment is the development of strength. The load is too small to call forth the full force of the muscle to move it. Speed, rhythm and load may be varied to elicit the desired physiologic effect.

The optimum speed of exercise is roughly proportional to the range of motion. For example, flexion of the wrist through full range of movement, as illustrated in chart 4, is performed with comfort at a slower rate than the shorter range of abduction. In normal subjects the comfortable rates of speed for finger, wrist and radioulnar movements ranged from 40 to 60 contractions a minute, when performed by adults at an even rhythm in time to a metronome. The number of contractions per bout depend upon the condition of the muscle group and the severity of work desired. The number of bouts administered per treatment period depends also upon the patient's condition and the objectives of the exercise.

In actual practice the optimum contraction-relaxation rate is determined by trial at the time of the first treatment visit. At too slow speeds, energy is wasted in maintaining the contraction. High speeds are impossible because of the inertia in the system. The operator administering the exercise also determines by trial the load just capable of producing an asymptotic fatigue curve in 25 to 40 repetitive contractions at the selected rhythm. This may be complete or incomplete; that is, the fatigue curve may fall to zero in the requisite number of contractions or to some fraction of the initial extent of contraction. The latter is the more conservative procedure. Each series of contractions is called a bout and a rest pause of sixty seconds is allowed between successive bouts. From 10 to 20 bouts constitute one treatment period. As strength increases the slope gradient of each individual ergographic fatigue curve falls off and is gradually replaced by a fatigue level which becomes progressively higher and higher until the initial extent of contraction is maintained for the full series of 25 to 40 contractions. In our experience strength is augmented more rapidly if this is not allowed to occur. Just as soon as a clearly defined fatigue level appears, the load is increased. Thus, the patient exercises at a constant severity which is graded progressively to induce an arbitrarily selected degree of fatigue in the number of contractions which constitute a standard bout. If, on the other hand, the patient's condition regresses, the slope gradient of the fatigue curve becomes steeper and the patient may not be able to develop sufficient tension to produce contractions visible on the ergogram the required number of times. The

load is then lightened. As strength improves, the work may be made severer by the simple expedient of increasing the load, the rhythm of contraction or the total number of bouts or by reducing the rest pause between bouts. When there is jelling on inactivity, the involved joint may be mobilized by warming up with a light load before resorting to the heavy resistance selected for the development of strength.

Work done per diem is calculated by multiplying the total lift by the load. When graphed daily, this yields a simple objective record of progress. In the management of unilateral injuries, treatment may be continued until

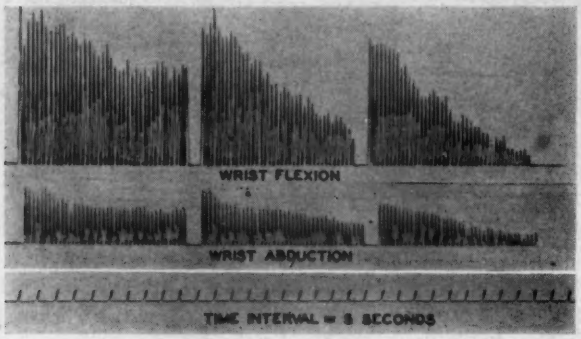

Chart 4. — Illustrative radioulnar ergograms showing the normal variations in extent of different wrist joint movements which affect the rhythm selected for repetitive exercise; load, rate and rhythm constant.

the work tolerance equals that of the uninvolved contralateral side. In bilateral injuries, the only alternative is comparison with as yet unavailable norms. The end point of effective treatment is indicated by plateauing of the training curve.

A simple and effective weekly "test day" may be introduced into the treatment program by starting with no load and increasing the resistance by equal increments with each bout until the standard number of contractions can no longer be attained. This is similar in principle to DeLorme's[16] "limit-day" procedure.

Physiologic Interpretation of the Ergogram

The instruments described permit simple normal range movements of the major articulations of the upper extremity. The repetitive excursion of the part under study is automatically recorded in the form of an ergogram. When the moving part is loaded as described, the initial power exhibited by the muscles falls off rapidly. The load can no longer be raised with the greatest volitional effort. A transitory rest pause is associated with an astonishing ability to develop tension of much the same magnitude as that demonstrated initially. As the exercise continues, the total work done per bout falls off progressively. However, after 600 to 800 maximal volitional contractions of isolated muscle groups of the forearm, the tissues concerned enter into normal activity with no sensible impairment in functional capacity.

The dramatic fatigue of ergographic exercise is predominantly central. Work falls off, not because of diminution in the contractile power of the muscle fibers, but largely by virtue of failure in volitional innervation. Reid[17] demonstrated that when the muscle ceases to respond volitionally after repeated effort, electrical stimulation of the nerve trunk, motor point or muscle

16. DeLorme, T. L.: Restoration of Muscle Power by Heavy-Resistance Exercise, J. Bone & Joint Surg. 27:645 (Oct.) 1945.
17. Reid, Charles: The Mechanism of Voluntary Muscular Fatigue, Quart. J. Exper. Physiol. 19: 17, 1928.

fibers elicits a brisk and normal response. Indeed, it is remarkably difficult to bring about muscular fatigue in the intact experimental animal. Reid found it impossible to induce complete fatigue in approximately 10,000 successive contractions of the flexor digitorum sublimis muscle in man, stimulated electrically, and as many as 50,000 contractions were required to approach a condition resembling complete fatigue in the rabbit when the tibialis anticus muscle was stimulated by way of its intact nerve supply with single induced shocks.

One of the most constant phenomena observed in ergographic training is the progressive extension of the subject's willingness to put forth maximal effort and continue muscular work after fatigue has made it painful. Sense of fatigue appears to be a fallacious index of the true working capacity of muscle. There is no physiologic evidence that persistence of volitional effort, once central fatigue sets in, can have any detrimental peripheral effect on the contractile tissue. The margin of safety appears to be large. Indeed, it is only as the subject becomes increasingly inured to the discomforts of repetitive effort that work tolerance augments. Since realizable work is so inextricably linked with the psychologic qualities necessary for maximal volitional innervation, the objective character of the ergogram may be made to serve as a constant stimulus to the exercising subject.

The individual strokes of the ergogram depict the sequence of events occurring during contraction. They record the ability of the patient to develop and release tension smoothly and rhythmically. The contraction is at first isometric. When sufficient tension has been developed to overcome the load, the contraction becomes isotonic. The muscle then exerts its full force in lifting a constant load through the normal range of motion. It is impossible to avoid a transitory period of isometric contraction at the height of the upstroke of the repetitive movement cycle. This becomes more and more pronounced during the terminal phases of each ergogram, when the extent of contraction is too small to occupy the time allowed for the stroke. The tension thus momentarily maintained when the muscle reaches its shortest possible length then falls off smoothly as the muscle elongates. At the end of the stroke there is no alteration in the length of the muscle fibers. The exercised part relaxes to its normal resting position and after an insensible pause contracts again. Relaxation is not complete. Considerable residual tonus remains, as though to expedite the reapplication of tension at the next anticipated signal of the metronome.

In both the original Mosso ergographic technic and DeLorme's heavy resistance exercise, the muscles concerned sustain the load at the end of the contraction cycle. This stretches the fibers beyond their normal resting length. This is especially evident in DeLorme's exercises, which are of necessity performed slowly, with considerable rest pause between successive efforts during which no external work is done while supporting a very heavy load. The maximum tension developed from a position of stretch is greater than that volitionally elicited when the muscle is "after loaded" as in our ergographic technic.

In calculating work done, no account is taken either of the brief periods of isometric contraction which initiate and end each upstroke of the ergogram or of the energy required in lowering the weight slowly against the pull of gravity. Only realizable work is measured. This in no way invalidates the method, for industry is likewise concerned solely with productive movements.

We have never observed muscle soreness in judiciously administered ergographic exercise performed by a patient. Delayed stiffness and localized muscle pain was sometimes reported by normal subjects doing very severe exercise daily. This was marked at first but subsided after the initial bouts

of the day and usually occurred early in training. Prolonged and rigorous exercise was accompanied with considerable swelling of the muscle. In experienced laboratory subjects, accustomed to making an unrestrained "all-out" effort, the severity of the work done was associated with tenosynovitis, periarticular trauma and arthritis. Volitional work of this severity is possible only in highly trained persons and thus offers little or no complicating limitation to the clinical application of ergography. The microtraumas sustained by normal subjects left no residual disability.

Summary and Conclusions

A series of self-contained, ink-writing ergographs have been developed for the appraisal of the functional capacity of the major articulations of the upper extremity. Preliminary trial of these instruments suggests that —

1. Work tolerance may be estimated with greater accuracy ergographically than by judgment of the examining physician.

2. Ergography may be clinically useful in disability evaluation because it provides a simple quantitative tool by virtue of which the following measurements may be made:

(*a*) Initial functional capacity,
(*b*) Progress under treatment,
(*c*) The end point of effective rehabilitation,
(*d*) The degree of residual disability.

Credit is due Mr. James S. Hipple, mechanician of the State of Wisconsin General Hospital, University of Wisconsin, for the excellent construction of the instruments designed by one of us (L. E. A. K.) and for the contribution of features which led to the development of a series of sturdy and simple clinical tools sufficiently reliable to be useful for purposes of research.

Discussion

Dr. Ben L. Boynton (San Angelo, Texas): I am somewhat embarrassed because I did not get much of a chance to preview this paper, and I had to read it under rather difficult circumstances without seeing the illustrations. However, it is certainly a most interesting approach to a very real problem, and I think we would recognize at the very outset that here we have a method in basic research that is probably valid and will give us much useful information.

As far as general use is concerned, I should somewhat question such, what I might term, artificial methods for therapeutic use. The use of the ergograph in studying upper extremity disability occasionally and periodically to check progress, I can see would be a most valuable procedure. I doubt that for purely therapeutic use it is as good as some of the other methods we are using in physical medicine. For instance, I feel that occupational therapy, in which we have graded exercise and yet at the same time are stimulating the patient psychologically in a broader phase, rather than just watching the writing pen rise and fall, keeping the mind occupied and stimulating the patient psychologically, at the same time broadening his interest perhaps even developing skills in the way of vocational training, may be more valuable in the long run in the total picture.

I certainly enjoyed this paper. I appreciate the privilege of discussing it and am sorry to be so ignorant of the actual functioning of this apparatus, but it does have a place in basic research and clinically, I think, undoubtedly in giving us an objective measurement—at least periodically—as to the progress of the patient.

Dr. Max K. Newman (Detroit): I would like to make a short comment. I want to tell you how this thing has been applied clinically as compared to what they did by means of the ergograph.

The DeLorme exercise utilizes a principle which is an active resistive exercise. We can take that same principle and make it into an active assistive exercise by means of a few pulleys. If the patient were to have a lower extremity paralyzed, we attach a string of pulleys in connection with weights. We could say an active assistive exercise of the lower extremity would be ten pounds of weight. Then as the muscle power increases, he exercises eight pounds of weight and so on down to the normal point to zero when the patient has developed enough power to exercise the lower extremities until he has passed the point of zero when he would add weights again and then it is resistive exercise which is similar in principle to the ergograph and it is a simple method of exercise obviating the use of expensive therapeutic equipment.

DYNAMIC ASPECTS OF PHYSICAL MEDICINE IN THE VETERANS ADMINISTRATION *

A. B. C. KNUDSON, M.D.

Assistant Chief, Physical Medicine Division, Veterans Administration

WASHINGTON, D. C.

The interpretation of the word "dynamic" as used in this paper is that quality "characterized by energy or effective action."

Prior to the establishment of the Department of Medicine and Surgery of the Veterans Administration, the office of Physical Medicine of the Medical Service had been well organized and was steadily expanding in anticipation of the increasing load of hospitalized patients from Army and Navy Hospitals. However, General Bradley, upon assuming his duties as Administrator of Veterans Affairs, realized that in order to meet this problem adequately rehabilitation must be stressed and greatly expanded in scope. He was very definite in his desire that a complete Medical Rehabilitation program be inaugurated and executed in each Veterans Administration hospital so that every sick, injured and disabled veteran could be rehabilitated for purposeful living and a normal life compatible with his abilities and disabilities. The Physical Medicine Rehabilitation Service was formulated, and Dr. Paul R. Hawley, Chief Medical Director, appointed Dr. Donald A. Covalt to the position of Assistant Medical Director for Medical Rehabilitation to direct this service.

The world is familiar with the remarkable advancements made in Veterans Administration medical care since the planning and establishment of the Department of Medicine and Surgery in January, 1946. Truly, it has made possible a medical service second to none for our veterans. I wish to highlight the progress made in the field of Physical Medicine Rehabilitation and its specific contributions to this advancement.

A brief review of the development of this service over the past eighteen months is indicated. The Physical Medicine Rehabilitation Service was established to effect the broader aspects of total rehabilitation geared for treating the whole man from bed to the job and for preparing the veteran for normal living in his community. Thus, the finer concepts for restoration and resocialization of our veterans were conceived as part of an integrated program in which physical medicine would bring to bear every possible therapeutic means to treat the veteran on a personalized basis, to engender a desire to get well, to enhance his morale and confidence and to guide his vocational abilities toward economic independence.

In order to achieve this goal of supplementing definitive medical care in Veterans Administration hospitals, a Physical Medicine Rehabilitation Division was created in each of the thirteen branch offices in accordance with General Bradley's decentralization plan. A comparable table of organization was initiated in each Veterans Administration hospital at the operating level adapted to the specific type of hospital, whether General Medicine and Surgical, Neuropsychiatric or Tuberculosis. Physical Medicine as a major part of the entire service included the following component sections: (1) Physical Therapy; (2) Occupational Therapy; (3) Corrective Therapy; (4) Manual Arts Therapy; (5) Educational Therapy. In addition, there is an Aural Rehabilitation Division and a Blind Rehabilitation Division.

* Read at the Twenty-Fifth Annual Session of the American Congress of Physical Medicine, Minneapolis, Sept. 3, 1947.

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All rehabilitation activities in these various sections, are medically and individually prescribed for therapeutic purposes in a regimen of therapy emphasizing that (1) the whole man must be treated, not merely his disablity; (2) all rehabilitation procedures must be commenced early; (3) each step in the program for the individual patient must be progressive and (4) all phases of the patient's schedule must be integrated in such a manner as to be purposeful.

Physical medicine as conducted involves all the modern scientific technics and broader concepts of this specialty as outlined by the Council on Physical Medicine of the American Medical Association and conforms with the principles formulated by the Baruch Committee on Physical Medicine.

The situation with reference to qualified physiatrists has improved remarkably. In January, 1946, only 25 full time Chiefs of Physical Medicine were available in the Veterans Administration. At present there are 80 full time physicians on duty in this specialty and 40 part time physicians, supplemented by the consultant services of approximately 20 nationally known physiatrists.

Physical therapy is administered by physical therapists qualified in accordance with the standards of the American Medical Association and the American Physiotherapy Association. A whole new field of physical therapy procedures has been developed for tuberculous patients, providing two principal services: (1) instruction of patients in scientific relaxation as a means of achieving complete bed rest, which promotes the healing process; (2) special chest exercises, now being taught in the 37 chest surgery centers, for the prevention of scoliosis and other postural deformities frequently associated with chest surgery. Qualified physical therapists have increased from 102 to 531 at the present time.

Occupational therapy is likewise modernized to fit into the total design of rehabilitation. All therapy is geared toward functional actvities to restore usefulness. The personnel consists of therapists qualified through graduation from approved schools and adequate experience according to the standards of the American Occupational Therapy Association. There were 115 occupational therapists eighteen months ago; now there are 432 on duty.

Corrective therapy provides a program of reconditioning exercises medically prescribed on an individual basis to prevent deconditioning phenomena generally and to prevent muscular atrophy. Considerable advancement has been made by this section in Veterans Administration General Medical and Surgical and Neuropsychiatric Hospitals, as well as in our Spinal Cord Injury Centers. There are 366 corrective therapists on duty.

The Manual Arts Therapy program utilizes projects of an industrial, agricultural or trade nature therapeutically. Through them, a veteran is able to explore the possibilities and to determine the feasibility of continuing such activities as a posthospital vocation immediately or after further training under the Veterans Administration Vocational Rehabilitation and Education program. Vocational guidance is integrated with this and other aspects of physical medicine rehabilitation, in order that a determination may be made during hospitalization of the patient's aptitudes, abilities, interest and physical capacities. Thus the veteran learns not only what he likes to do but what he is able to do, both in terms of ability and in terms of any handicaps he may have. Such firms as International Business Machines Corporation, Eastman Kodak Co., Bulova Watch Co., Bausch & Lomb Optical Co., and the Radio Corporation of America have joined our efforts to help these men to find their way into purposeful activities which lead to useful jobs. Today there are 400 manual arts therapists in Veterans Administration hospitals.

Educational Therapy utilizes approved educatonal courses as mental therapy. A total of about 215 technical, business and academic courses of the United States Armed Forces Institute are now offered as correspondence, self-study and group instruction mediums. This work may be applied by a veteran toward credit for a high school diploma. The educational program is started for each patient on a prescription basis as early as possible during his treatment period. Approximately 20,000 veterans of both World War I and World War II have pursued such courses during the past year, covering a wide variety of subjects. More than 2,000 patients for whom this therapy was prescribed have received their high school diplomas during the past year. Forty-six state departments of education throughout the country now grant high school credit and issue diplomas for courses completed in educational therapy in Veterans Administration hospitals. Presently, 300 educational therapists carry on this work.

The dynamic success of this new type Physical Medicine Rehabilitation program was made possible only as a result of liaison of the Veterans Administration medical service with the class A medical schools of our entire country through the medium of deans' committees. It is apparent that every Veterans Administration hospital needs a medical school, and every medical schools needs the Veterans Administration hospital. The physical medicine rehabilitation program is keeping pace with the advance of medical knowledge in this field, and the dissemination of this knowledge by the physiatrists serves as a constant stimulus to the therapists who work under their supervision. Our Veterans Administration physiatrists have raised the medical standards for this specialty so high in our hospitals that there are few, if any, hospitals in the nation where a patient has such a wide selection of activity and therapy for his recovery.

This, however, by no means boxes the compass. Another vital contribution has been that made by all our consultants in physical medicine, serving in an advisory and guiding capacity to the central office, the branch offices and to each individual Veterans Administration installation in all of the branch areas. But there is another contribution which our Veterans Administration consultants in physical medicine have made and are continuing to make — a contribution which is probably the most important of all. They realized that in physical medicine, where knowledge is advancing so rapidly, it is particularly necessary that a physician keep up with the latest developments in his field. Failure to do so may result in the premature ending of human lives, lives of our veterans who deserve all that medical science can do to restore them to health. This contribution is in the matter of establishment of training programs and the development of residency programs in our Veterans Administration hospitals, in which our consultants have given their unselfish help and advice. In-training programs for Chiefs of Physical Medicine are being developed in many of the branch areas. In addition, Dr. Frank H. Krusen is making available courses of formal training for those physicians who have a sincere interest in this field as a permanent career. Presently, twelve full time Veterans Administration physicians are participating in such a formal course at the Mayo Clinic.

Several residency programs have been established or are being planned in our Veterans Administration hospitals in liaison with the local deans' committees of the affiliating medical schools. These residencies will provide adequate training in accordance with the requirements of the American Medical Association leading to certification as a specialist by the American Board of Physical Medicine.

Residency programs exist or are taking form at Veterans Administration

hospitals in the following cities: Atlanta, Ga.; the Bronx, New York city; Richmond, Va.; Minneapolis, Minn.; Denver, Colo.; New Orleans, La.; Los Angeles, Calif.; Portland, Ore.; McKinney, Texas; Jefferson Barracks, Mo.

These residencies provide for the patient a more complete and superior medical service than has been known in Veterans Admnistration hospitals heretofore. They are equivalent to those afforded by teaching hospitals and medical school clinics throughout the country. The residents serve to supplement the full time medical staff and in this way make possible the fulfilment of every medical requirement of the hospitalized veteran by providing sufficient medical man power to do the job. Since the emphasis in training by the Baruch Committee has been inaugurated in strategic medical institutions, the establishment of physical medicine residencies in Veterans Administration hospitals has been a logical development. The implications of this progress are self evident. It all adds up to the fact that more and more young physicians will be attracted to training in the field of physical medicine. It offers an opportunity for medical students to evaluate physical medicine as a possible specialty and to observe the program during their years in medical school. It will influence a larger and larger number of them to decide on physical medicine as a career, and many of them will eventually come into the Department of Medicine and Surgery as full time Chiefs of Physical Medicine.

Until a sufficient number of residents complete their training in physical medicine in Veterans Administration and other hospitals, the difficult job of recruitment must continue, in spite of the fact that the number of available physicians trained or experienced in this specialty is small. However, the results of an active recruitment program have been surprisingly good, as was pointed out previously. Several experienced physiatrists and recently graduated Baruch Fellows have been appointed to full time positions.

Let us look for the moment at the research phase of Physical Medicine Rehabilitation in the Veterans Administration. You will perhaps not be surprised to hear that plans have been laid for a sound scientific research program for the study and investigation of many unsolved problems in physical medicine. This will be coordinated with the Medical Research and Education Service, which evaluates administratively each submitted project and then forwards the problem to the National Research Council for further technical review and recommendations. If a specific project is approved, the research is done in the hospitals, always in close contact with the nearest research center of the Veterans Administration for the use of highly specialized equipment and the help of technical personnel devoting full time to research. A mounting knowledge of the scientific basis for physical medicine methods is realized. It is further acknowledged that such research must be of high quality so that it can serve as a keystone for expansion of this specialty and to combat many panaceas currently being proposed by charlatans.

Physical Medicine Rehabilitation is accumulating complete statistics and clinical data on all patients treated in Veterans Administration hospitals by physiatric methods. Basic plans for necessary and important research projects are being developed, so that quantitative research data may be obtained and published for the benefit of all interested in this field as well as for the medical profession as a whole. The uniqueness of medical progress in the Veterans Administration and the vastness of clinical material in Veterans Administration hospitals offer opportunities for research unparalleled in the past.

An effective means of educating general practitioners, other specialists and professional people, as well as lay groups to the accomplishments and possibilities of Physical Medicine Rehabilitation has been pursued in the development and execution of a number of "live" exhibits showing the spheres

of activity of all sections of this service by means of actual patient demonstrations. The two scientific exhibits presented at the Annual Sessions of the American Medical Association, last year at San Francisco and this year at Atlantic City, in coordination with the Special Exhibit Committee on Physical Medicine of the American Medical Association, were very successful. They were a part of a total composite exhibit on physical medicine which served to educate at least 10,000 physicians regarding the benefits of physical medicine. These exhibits have also been modified for lay consumption and utilized at meetings in all parts of the country.

A vitalizing contribution to the influence of physical medicine in our Veterans Administration hospitals is that made available by the establishment of medical rehabilitation boards. Such a board is a definite, positive factor in shortening the time of hospitalization for each veteran considered by that board during his stay in the hospital. It exemplifies the mission of teamwork in the recovery of the whole man, the physiatrist serving as captain of the team of specialists composing the board. This team of hospital staff members carefully considers every tangible aspect of the veteran's illness in connection with his personality, his home environment and the civilian occupation in which he was previously engaged — all directed toward the achievement of the most suitable vocation for him on discharge from the hospital. Owing to the fact that each board member contributes to the veteran's consideration according to his particular specialty, there is little possibility of error in guidance — thus avoiding repetition and loss of time in converting to new objectives. The personalized attention rendered by each member guarantees the veteran's maximum recovery in the shortest possible time. He is thus equipped on discharge to return to his community and make a satisfactory adjustment physically, mentally, socially and vocationally.

We wish to be sure that disabled veterans will be able to compete successfully with non-disabled workers, and that their disabilities will not affect the quality of their work, or hinder their opportunities for advancement. The Physical Medicine Rehabilitation program not only speeds the recovery of these patients, thus shortening hospitalization, but also reduces the number of readmissions for further or repeated treatment. This has served to reawaken an interest in the rehabilitation of the seriously ill and severely disabled, both on the part of the general public and the medical profession.

Aside from the establishment of several Spinal Cord Injury Centers — Framingham, Mass.; Van Nuys, Calif.; Hines, Ill.; Memphis (Kennedy), Tenn.; Richmond, Va.; the Bronx, N. Y., and Staten Island, N. Y. — the Physical Medical Rehabilitation Service is expanding in other directions. A special rehabilitation center for tuberculous veterans has been established at the Veterans Administration Hospital at Swannanoa, N. C., in order that the "hardening process," so essential to a permanent recovery, may be achieved under ideal conditions. In this center, attention is given both to the clinical findings and to a rehabilitation program for each patient which will enable him to live within his physical capability. This will prevent recurrences, which have kept our tuberculosis hospitals filled with returned patients.

The Veterans Administration has just opened, two days ago, a special rehabilitation type hospital at Fort Thomas, Ky. To this hospital will be sent those patients with difficult, long-term chronic conditions, who, in the opinion of the physicians, can achieve a more rapid and permanent recovery in a hospital devoted entirely to severely disabled veterans. It combines two desirable features: 1. The severely disabled veterans benefit from a hospital devoted entirely to their specialized needs. 2. More urgently needed beds are freed in other hospitals for patients with acute conditions. A year ago

there were 114 hospitals; now there are 126, and still there is a shortage of beds.

A case is cited of a 29 year old World War II Army veteran admitted to a Veterans Administration hospital Dec. 27, 1946, disabled by severe generalized arthritis. Previously he had been treated in Army hospitals with various therapies, including penicillin, fever therapy, blood transfusions and baths. His weight had dropped from 194 to 138 pounds, and he was discharged from the Army and Navy Hospital at Hot Springs, Ark. After admission to the Veterans Administration hospital and subsequent referral to the Medical Rehabilitation Board, he was studied carefully and given careful guidance by each member of the team. He began to show some improvement and then continued to make gradual constant progress, receiving physical therapy, occupational therapy, corrective therapy and educational therapy. All activities were graduated to conform with his improvement. An intensive educational program was prescribed after a vocational advisement interview. A report of April 7, 1947, states that the consultant physician in this case had said that the patient had responded very well in all physical medicine rehabilitation activities. The physician called attention to the unusual progress of this patient following referral to the Medical Rehabilitation Board.

It was the opinion of the consultant that such progress could not have been possible if the patient was not cognizant of the zeal and cooperativeness of each board member in assisting him to overcome his disability. Finally, the patient's work tolerance was determined, and preparation was made for his discharge. The social service member of the board stated that the patient's home environment was favorable for his return. After his discharge, the tentative date of May 5, 1947, was decided on for his reporting to work with the Railway Express Company, where he was to be employed as a rate clerk. It was the opinion of the Medical Rehabilitation Board and the consultant that this patient would be able to perform his duties capably; this opinion has been confirmed by a later report.

Thus the patient was treated as well as his disease. Both the science and the art of medicine were utilized in the successful restoration of a veteran to independent citizen status in his community.

Further accomplishments in an energetic attempt to realize a higher level of efficiency in Physical Medicine Rehabilitation are the planning and development of specialized training courses for each subdivision of physical medicine. Teaching facilities are being expanded as rapidly as available personnel in scarce categories will permit. Manuals are being published defining the principles and methods of new technics for the guidance of personnel; films are being completed for use both as training guides and for public relations objectives.

In this way the Physical Medicine Rehabilitation Service is making steady progress toward its three primary objectives: (1) to help patients to leave the hospital sooner; (2) to discharge them in such condition that they may remain out of the hospital; (3) to offer an opportunity for those severely disabled veterans who otherwise might be committed to permanent hospitalization for the remainder of their lives.

In relation to these objectives an example of group success in restoration is cited. For the past year, the Physical Medicine Rehabilitation Service and the Neurological Service of the Veterans Administration Hospital at Minneapolis have been directing their efforts toward patients of World War I with long-term, chronic, neurologic conditions. Many of these veterans had been confined to bed for as long as ten years. They required constant medical attention and nursing care. At the end of the year, by means of

these concentrated rehabilitation efforts, the following results were evident. Of the total number of 130 patients in this series, 25 have been completely rehabilitated and are capable of taking care of themselves. They are out of the hospital and are self supporting. Forty patients have improved sufciently to return home capable of doing some work. Thirty patients are up and about, sincerely continuing their rehabilitation projects and with a favorable outlook. Twenty-five patients have demonstrated their ability for self care and will probably not advance further in their progress. Only 10 patients of the 130 have failed to show some worth while improvement.

Thus, aside from the humane aspect of getting these chronically ill patients out of the hospital and back to their community as self-supporting citizens, there is a tremendous saving to the government by reducing the period of hospitalization. These World War I veterans have a life expectancy of at least six years. In six years, at an average patient day cost of $10 per day for hospital care, the 25 patients who have left the hospitals and are now self sufficient economically will mean a saving to the government of over half a million dollars.

Recently, 30 paraplegia veterans of World War II who had begun a course in watchmaking while in the hospital were able to be discharged from the hospital and continue their training in the Bulova School of Watchmaking at Woodside, Long Island, N. Y. When that training is completed these men will be able to hold down good jobs in various phases of watchmaking and repair. This accomplishment of these veterans represents an outright saving to the government of some $93,000 during the next year alone. It is evident then that physical medicine rehabilitation pays off economically!

One paraplegic veteran is working as a full-time employee in the brace shop at a Veterans Administration hospital. This veteran was trained in the art of bracemaking as part of his rehabilitation program and has not missed a day on the job since he started, last September. He hopes to work a full year without being absent so as to prove that severely disabled veterans are capable of contributing to their own livelihood if given an opportunity. Another paraplegic patient is working full time in an office of one of our Veterans Administration hospitals. Recently he married and is now living a happy, useful life. We have bilateral arm and leg amputees employed in the Veterans Administration, as well as veterans who are totally blind. Another veteran learned watchmaking so well while he was a patient in a Veterans Administration tuberculosis hospital that when he was discharged he was able to secure a Civil Service appointment as a watchmaking instructor. Veterans who have been rehabilitated while hospitalized in Veterans Administration Neuropsychiatric Hospitals have obtained jobs in the Veterans Administration subsequent to their rehabilitation. The Veterans Administration believes in the dynamic rehabilitation of the disabled veteran and his effective employment following his restoration to usefulness.

The physiatrist's job today is much broader than it was a few years ago. He must have ability to make sound judgments based upon the changing trends and complicated advancements in the expanding field of physical medicine. He must be open minded and flexible in his thinking, with enough imagination to visualize some of the possibilities which will come to pass in this specialty. He must have a background of knowledge in many subjects to combine with this imagination in order to achieve the objectives of physical medicine. In addition, he should have intellectual curiosity and a research point of view, coupled with the ability to place quickly into actual practice the results of research in this field. Perhaps there is no other field of human endeavor where the transition from knowledge to use can be so effective.

In view of these dynamic trends of development in physical medicine

rehabilitation in the Veterans Administration, there is little chance of reverting to an outmoded type of program in the future. During the past eighteen months the progress in physical medicine in the Veterans Administration has been as dramatic as the dynamic results which it has made possible. Physical medicine has progressed far, but, unfortunately, not far enough. It is not enough that the wheels of medical progress continue to turn if that same progression does not bring to all our veterans the maximum in physical ability, mental stimulus and social adaptability to return to their communities to take up their work where they were forced to stop when illness or injury occurred.

Even on this occasion of our Annual Session we would do well to remember the unsolved problems which lie ahead, to remember the thousands of our veterans who remain sick and disabled and who require rehabilitation back to health and a job, back to their families and a place in community life. War has created an obligation which canont be denied. We in physical medicine will meet this obligation!

The discussion of this article will be published in a later issue of the ARCHIVES.

THE BIOLOGIC AND PHYSIOLOGIC EFFECTS OF ULTRAVIOLET RADIATION *

EDWARD E. GORDON, M.D.†

NEW YORK, N. Y.

The efficacy of ultraviolet radiation in rickets and extrapulmonary tuberculosis stimulated widespread empirical and often noncritical application to many clinical conditions. Extravagant claims created undeserved prejudice, even in proper application of this therapy. On the other hand, the success attained in the investigations on the vitamin D group and on the structure of the cell nucleus, for example, indicates that the quantitative study of biochemical systems involved offers a more fruitful approach to the action of ultraviolet rays. This is so, simply because rays from this region of the spectrum involve the transformation of radiant energy into chemical energy in the absorbing medium. Such a process is designated as a photochemical reaction.

Familiar examples of photochemical reactions are the photosynthesis of sugar by green plants, photography and irradiation of milk to enhance the vitamin D content. Less known are the enormous number of photochemical reactions, both organic and inorganic, which have been studied quantitatively in vitro and are well understood.[1]

Basic to the knowledge of the action of ultraviolet light is the particular wavelength of the radiation in question. To talk merely of "ultraviolet" without defining its energy and spectral distribution, would be as incomplete

* Read at the New York Society of Physical Medicine, at the New York Academy of Medicine, Nov. 5, 1947.

† Baruch Fellow in Physical Medicine, Columbia Presbyterian Medical Center.

1. Ellis, C., and Wells, A. A.: The Chemical Action of Ultraviolet, New York, Reinhold Publishing Corp., 1941.

as to omit the particular substance receiving radiation. This applies whether one is describing a chemical reaction or a biologic process. The wavelength characterizes the properties of the radiation — i. e., its penetrability, its chemical effects, its energy content and, in the final analysis, its utility.

The energy transfer involved in photochemical reactions is best explained on the basis of the quantum theory. A source of radiant energy emits "bundles of energy," or photons, the amount of energy being multiples of 1 photon. The magnitude of a particular photon depends directly on the radiation frequency and is expressed as the product of a constant times this frequency.[2] Hence, since the shorter the wavelength the higher the frequency, 1 photon (or unit of energy) at 3,000 Å, for example, will be twice as great as one at 6,000 Å. This relationship explains why the very short roentgen ray is so much more destructive to matter tnan the ultraviolet ray. As an analogy to help understand the concept and properties of a photon, one may refer to the accepted principles of classic chemistry. The smallest unit of matter is the atom and its magnitude depends on the particular element in question. Similarly, the smallest unit of radiant energy is the photon, the magnitude of which depends on the particular frequency.

Two basic laws govern photochemical processes: 1. The radiation must be absorbed by the reacting substance. 2. the absorption of radiation is a process involving the capture of usually 1 photon (or more) per reacting atom or molecule. The mechanism of the action of ultraviolet radiation depends on the absorption of a quantum of energy by the substance with a shift in the valence electron, thereby activating the molecule for chemical reaction. With roentgen radiation the quantum absorbed is larger and other inner electrons become affected. Infra-red radiation, having small quantums of energy, increases the kinetic energy of the molecules and hence causes only a rise in temperature.

In this review, photochemical changes following ultraviolet radiation will be limited to substances of biologic and physiologic interest only. Of these, nucleoproteins and proteins are of paramount importance, since the former is one of the most essential constituents of the nuclear material while the latter is abundantly present in the cytoplasm. Both absorb certain frequencies, leading to chemical reactions with the disruption of the molecules and, if tissue is irradiated, to injury or death of the cells.

Protein molecules absorb radiations in a characteristic way with a maximum at 2,800 Å; unfolding and breakdown of the molecules result. In vitro, albumin can be denatured and a coagulum of changed color and odor appears. Other substances of protein nature respond similarly: fibrinogen is precipitated from solution; insulin loses its hypoglycemic effect, and enzymes are inactivated. In unicellular organisms, cilia, being protein in structure, cease motion with irradiation at 2,800 Å. In higher animals, only the epidermal cells are affected, since penetrability of ultraviolet radiation is limited. It appears that the action on the protein molecule results from absorption by and disruption of the constituent cyclic amino acids, tryptophan, typrosine and phenylalinine. Radiations of frequenceis below 2,300 Å are absorbed by all amino acids. The exact mechanisms here involved are still obscure, but probably deaminization occurs.

To understand the reaction involving nucleoproteins, one must remember that these substances contain nucleic acid linked to certain proteins. The nucleic acid molecule is a complex one, built up of pentose, phosphoric acid and the heterocyclic compounds, purine and pyrimidine bases. These two bases strongly absorb radiations in a narrow ultraviolet zone, the maximum being at 2,600 Å with disruption of the rings. They alone account for the

2. $E = hf$, where h is Planck's constant, 6.55×10^{27} erg-second.

action of this spectral region on nucleoproteins and, consequently on the cell nucleus.

Because this property of nucleic acids to absorb specific radiations, ultraviolet rays have been employed as an investigative tool to disclose the secrets of the structure and metabolic events in a living cell. Briefly, brilliant results have been achieved, utilizing three main methods of approach: (*a*) Determination of the absorption spectrum in a particular region of a cell and comparison with known absorption spectra. Thus, the identity of the absorption spectrum of the nucleus with that of nucleic acid indicates its presence there. (*b*) Quantitative determination of known cell constituents in situ by determining the degree of absorption. This allows estimation of nucleic acid in the order of magnitude of 10^{-6} mg. (*c*) Comparison of absorption spectrum with an "action spectrum." The latter relates a series of wavelengths to their effectiveness in producing a given result. Thus, if the action spectrum of the bactericidal effect of ultraviolet radiation corresponds to the absorption spectrum of nucleic acid, one may infer that mainly this substance is altered in the lethal photochemical effect on bacteria, and hence the cell nucleus is destroyed.

With these methods in conjunction with the Köhler microscope, which utilizes an ultraviolet radiation source, nucleic acid components of the cell nucleus have been found to play a most important part in metabolic processes and in the complicated structure built up during cell division. The microscope depends on the fact that since different constituents of a cell (protein or nucleoprotein) will selectively absorb given wavelengths, differences in structure can be visualized without staining by photographic means or by a fluoroscopic screen. Some of the important findings, presented fully in a monograph by Caspersson,[3] are the following: 1. The nucleus has a high content of nucleic acid, up to 10 per cent. 2. Nucleic acid becomes concentrated in the chromosomes, which are constructed of alternate segments of nucleic acid and protein. 3. Nucleic acid increases just before cell division and decreases at completion. 4. Ultraviolet irradiation is most destructive at the prophase, causing a break-up of the chromatin material. 5. Mutations are most effectively produced by wavelengths of 2,600 Å, again implicating nucleic acid in the process of cell reproduction. 6. Concentration of nucleic acid in the nucleus changes during functional activity of gland cells. In addition, the ultraviolet microscope affords a method of studying cell architecture in the living cancer cell.

The lethal effects of ultraviolet radiation on bacteria, fungi, viruses and bacteriophage are well known. It has been shown that the action depends on the disruption of the constituent nucleic acid molecule by absorption of the characteristic wavelengths in the region of 2,600 Å. Mutations have been produced to useful ends in Penicillium notatum to obtain richer yields of penicillin. The utility of ultraviolet radiation in air sterilization of schools, wards and operating rooms is also well established.

Other biologic effects may find use in the field of immunology. In animals, irradiation appears to raise the antibody titer against typhoid and accelerate antibody formation when killed typhoid and Bacillus coli organisms are injected. Moreover, poliomyelitis virus when irradiated is detoxified without losing its antigenic properties for mice. The same applies to other toxins. As yet these findings have not received clinical application.

Every one has, no doubt, experienced the famliar physiologic effects of ultraviolet rays — sunburn and suntan. What has been said in relation to the biochemical processes concerned in the energy transfer of ultraviolet

3. Caspersson, T.: Skand. Archiv. f. Physiol. 73 (Supp. 8), 1936.

radiation in general can be likewise applied here. Obviously, only epidermal cells are involved.

Erythema is produced by wavelengths below 3,200 Å, the action spectrum displaying two maxima, 2,950 Å and 2,500 Å, which are thought to correspond to the absorption of protein and nucleic acid, respectively.[4] The former zone is by far the most effective, suggests a process of protein destruction, especially since the superficial cells are rich in cytoplasm.

The various events taking place in the epidermis after strong radiation (sunburn) can be followed histologically: 1. After a latent period of a few hours there is engorgement, enlargement of capillaries and intracellular edema. 2. Later, leukocytes leave the capillaries in the corium and migrate to the epidermis. 3. Twenty-four hours later degenerative changes in the stratum germinativum are observed. 4. After the active stage, proliferation of all epidermal layers takes place, including thickening of the corneum. 5. With fading of the erythema, pigmentation ensues.

This procession of events has been interpreted to be due to the release in the epidermis of substances with specific actions following cell injury by the photochemical disruption of the constituent protein.[5] These are (1) a vasodilator H-substance or substances, slowly released as a result of cell injury and producng a picture of inflammation rather than one of histamine effect; (2) a leukotaxin exerting a chemotactic effect on leukocytes and increasing capillary permeability; (3) a necrosin prolonging still further the destructive effect on the cells. Since fever may result after a sunburn, a pyrexin may also be assumed.

The second event following exposure to sun or other ultraviolet sources is tanning. Normally, melanin pigment can be found in the basal layers of the epidermis. A few days after exposure, while the basal cells are free of pigment, melanin is found in the upper layers, including the stratum corneum, but the total epidermal pigment remains unchanged. This must mean a migration of old pigment to the surface. Later, new melanin appears in the basal layer and also migrates upward. This process, however, is not the result of a specific photochemical reaction. In the first place, other means of cell destruction, such as friction, burn, and inflammation, can produce pigmentation; in the second place, the action spectrum for melanization is the same as that for production of erythema. Therefore, from the breakdown of cell protein it appears there is produced some substance — a melanotactic factor — which is responsible for these changes.

On the other hand, it has been shown that a second mechanism for pigmentation also occurs. This is a true photochemical reaction and is known as a pigment-darkening reaction. Briefly, the existence of this second mechanism, distinct from the melanotactic process, rests on the following evidence: 1. The action spectrum ranges between 3,200 and 4,200 Å, and pigmentation can be produced through glass. 2. There is no latent period, darkening occurring in a few minutes rather than in a few days. 3. A greater intensity of exposure is required. 4. Pigmentation occurs only in the presence of oxygen, in contrast to pigmentation following erythema. 5. Wavelengths above 3,200 Å do not cause pigment migration. 6. Pigment darkening can be demonstrated on cadavers. These facts can be interpreted only as a photochemical oxidation of bleached pigment already in the skin from previous tanning. This explains why darkening is more in evidence with exposure to sunlight than to artificial sources of lower wavelengths. Incidentally, it has been observed that sex hormones also darken skin in previously tanned areas.

In summary, then, there are two mechanisms involved in suntan — first,

4. The opinion is ventured that since epithelial cells are rich in cytoplasm the two absorption maxima are both due to protein constituents, one to the cyclic amino acids and the other to all the amino acids.
5. Blum, H. F.: Physiological Effects of Sunlight on Man, Physiol. Rev. 25:483 (July) 1945.

a release of a melanotactic factor causing migration and formation of new pigment after a few days and, second, immediate photochemical oxidation of old bleached pigment in the epidermis by longer wavelengths.

Immunity to sunburn, as previously thought, is not due to melanization. Thickening of the stratum corneum effectively screens the erythema-producing radiations and this is what mainly affords protection from further injury. This opinion is supported by several facts. The corneum is an excellent absorber of wavelengths below 3,000 Å, and following an erythema hyperplasia of the epidermis with thickening of the corneum has been demonstrated. Furthermore, in line with this, vitiligo patches and the skin of albinos are more resistant after exposure. The palm and soles, where the corneum is thickest, do not burn. Pigmentation, therefore, plays a distinctly minor role in protection against sunburn.

Sunburn of the eye, or photophthalmia, is due to an action similar to erythema of the skin, except that there is no pigmentation and the corneal cells do not proliferate to produce an immunity.

Minor physiologic effects of exposure to ultraviolet radiation, probably depending on the absorption of H-substances, may be mentioned in passing — for example, a transient and small decrease in blood pressure and a rise in gastric secretion. Red blood cells and platelets and blood coagulability have been reported to rise with repeated exposures, but these points are controversial. A negative nitrogen balance and increased excretion of uric acid have been reported in animal experiments, but other factors were not excluded.

Regarding the problem of abnormal sensitivity to ultraviolet radiations, the mechanism involving the release of H-substances in the production of erythema appears to square with accepted notions of allergy. This hypersensitivity is produced only by radiation frequencies below 3,200 Å. In other words, the action spectrums of normal erythema and hypersensitivity coincide; hence, it is reasonable to assume the same photochemical products in the former as in the latter. The marked reaction of the sensitive person may depend on either a greater sensitivity of his tissues or an allergen-antibody reaction which itself produces further cell damage with a pronounced erythemal reaction. The latter reasoning is supported by the fact that humeral transfer of photosensitivity is possible. When blood is taken from a susceptible person and injected intradermally into a normal one, the site of injection shows a marked reaction with exposure to rays under 3,200 Å. Such transfer may best be explained on the basis of circulating antibodies from the donor combining with antigenic protein breakdown products in the recipient. The combination of the two may give rise to an allergen-antibody reaction with the further liberation of H-substances. Such a mechanism has not been actually proved as yet. In other conditions, hypersensitivity appears to depend in some fashion on local circulatory changes in the skin. Thus in hypertension, vasomotor instability, hyperthyroidism and in sympathectomized areas, erythema is readily produced by weak intensity of radiation. After removal of the thyroid gland, photosensitivity disappears.

Recently, a report has been published on the efficacy of pyribenzamine in reducing photosensitivity to erythema-producing rays.[6] This evidence is another link in the concept implicating the action of H-substances in ultraviolet radiation. It is of great theoretical and practical interest to find whether the antihistamine drug can prevent sunburn in normal people.

The presence of certain photodynamic dyes has long been known to exaggerate the effect of these rays in vivo. In vitro, certain salts of heavy metals and certain dyes like eosin can be shown to potentiate the effect of

6. Rubin, L.: J. Investigative Dermat. 8:189, 1947.

nonlethal intensities of radiation on unicellular organisms, with resulting death. Apparently, the dye molecule becomes activated by the absorption of 1 photon of energy and is then capable of transferring the captured energy to a suitable substrate, resulting in a chemical reaction. When dyes are injected into animals, severe erythema and death are readily produced. Drugs of the sulfonamide class fall into this category, and one must be aware of this fact in therapy. Porphyrin has also been incriminated as a photodynamic dye, since clinically, porphyrinuria does occur. In vitro, this substance acts as a light sensitizer. However, all good evidence argues against its clinical importance: 1. In animals enormous amounts, far exceeding clinical levels, need to be injected to produce a photodynamic action. 2. Porphyrin requires the presence of oxygen, whereas the erythema of light sensitization proceeds without it. 3. The action spectrum for porphyrin differs from that of erythema.

The most intensively studied and best known photobiochemical reaction is that relating sterol metabolism to the vitamin group. Much has been written, and accordingly, the facts will be entertained only briefly. The plant sterol ergosterol, when irradiated with ultraviolet rays, absorbs wavelengths under 3,200 Å and undergoes a complicated reaction, yielding, among other substances, an active compound, vitamin D_2. The animal sterol 7-dehydrocholesterol undergoes a similar change, yielding vitamin D_3. The latter is more potent against rickets than the former. Evidently, the provitamin is present in the corneum and upper layers of the epidermis, since radiations below 3,200 Å are effectively screened. Other D vitamins can be produced by starting with different precursors, but they all are similar in respect to the breaking of the bond between the carbon atoms in positions 9 and 10.

The effect of ultraviolet radiation on rickets through the mediation of a chemical substance produced locally and exerting a distant action suggests that possibly a similar mechansm may account for the favorable influence of ultraviolet rays in other systemic conditions. Extrapulmonary tuberculosis may be one such condition.

Deleterious effects of ultraviolet radiation have recently been suspected, leading to skin cancer. The evidence is mainly statistical but impressive: 1. The incidence of skin cancer is greater in lower latitudes. 2. Of skin cancers, 95 per cent occur on exposed regions like the face and hands. 3. There is a greater incidence in outdoor than in indoor workers. 4. White persons are more affected than Negroes. Moreover, neoplasms have been induced in mice by radiations below 3,200 Å, although it must be pointed out that sarcoma, rather than carcinoma, has resulted. Moreover, corneal tumors, which occur mainly in the southern population, can also be produced in mice. The mechanism is unknown. Possibly one or all of three methods may be responsible: 1. Mutation of cell chromosomes by action of the rays on nucleic acid. 2. Carcinogenic breakdown products of cell substances. 3. Presence of precancerous lesions in the skin.

In conclusion, it may be emphasized that, wherever the application of quantitative methods and the study of biochemical processes involved have been made, much has been contributed to the understanding of the action of ultraviolet radiation. Further advances in this field will come only from studies in terms of basic photochemical reactions and energy relationships, rather than from purely empirical data.

622 West 168 Street, New York City.

TRACING DEVICE FOR SURFACE LESIONS *

LOUIS B. NEWMAN, M.D.

Chief, Physical Medicine Rehabilitation Service

Veterans Administration Hospital

HINES, ILL.

In order to check the progress of any surface lesion, such as decubitus ulcers, varicose ulcers, wounds of all types and other skin lesions, I have developed a simple device for securing a tracing of the lesion. Guttmann[1] has described a two film method for tracing lesions. Many authors have photographed the lesions, while others have measured the lesions with a standard rule or have made imprints on paper or gauze by direct contact with the lesion. With the device described in this article, tracings of the lesion can be made periodically and checked with the previous tracings to note any change in size or contour. Further, with this method, no direct contact is made with the lesion. The technic is simple, and the procedure can be done by the therapist. The resultant tracing not only is an exact size permanent record of the lesion but is helpful in evaluating any treatment that has been instituted.

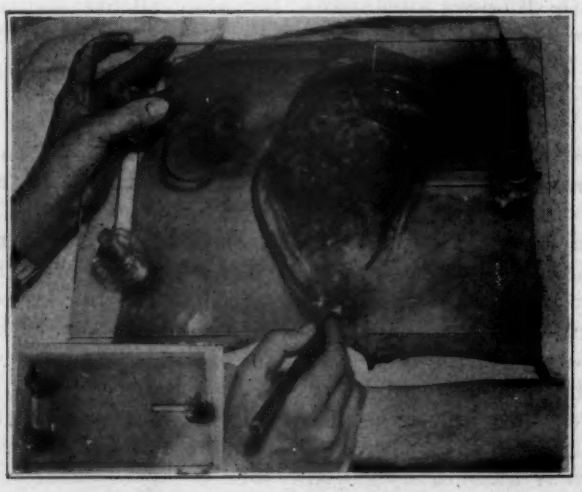

Fig. 1. — Procedure of making tracings of decubitus ulcer directly on plastic plate of plastic tracing device; device with three adjustable legs shown in inset (lower left).

The device consists of a transparent rectangular plastic plate 9 by 14 inches and ¼ inch thick. There are three adjustable legs which are adjustable not only for height but for position on this plastic plate. The ends of the legs that come into contact with the skin are 1 inch in diameter and have rounded edges so that the skin will not be injured on contact. These legs are long enough that the adjustment can be over a distance of approximately 2½ inches. The three legs are so spaced as to serve as a tripod in order that the tracing device will be stable, even though used over irregular surfaces. Plastic

* Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the author.

1. Guttmann, L.: New Hope for Spinal Cord Sufferers, M. Times, New York 73:318 (Nov.) 1945.

rectangular plates can be constructed of varying sizes, depending on the general size of lesions to be treated — i. e., a plate for face lesions can be 3 by 2 inches.

The technic for using this tracing device is as follows: All dressings are removed to expose fully the lesion to be traced. The three legs on the tracing device are so adjusted as to bring the under surface of the plate as close as possible to the lesion, yet avoiding contact. By means of any special pencil that will mark on glazed surfaces, the outline of the lesion is carefully drawn on the surface of the plastic plate, as shown in figure 1. In the lower left corner of figure 1, the tracing device with the three adjustable legs is shown. It is necessary to have the line of vision perpendicular to the edge of the lesion to avoid any errors of parallax. When the tracing is completed, the rectangular plate is removed from the patient. A standard size sheet

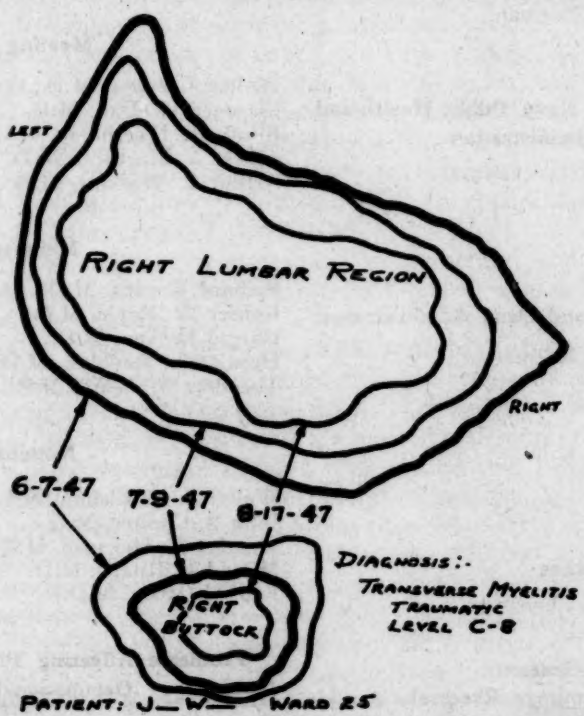

Fig. 2. — Tracings of decubitus ulcers made on thin paper on three different dates, showing changes in size of ulcers.

of thin semitransparent paper is placed over the tracing device, and the outline is traced on this paper with pen or pencil. The patients name, ward, diagnosis, dates of tracings, and location of lesion, are recorded on the sheet as a permanent record (fig. 2). When the lesion is traced from time to time, the tracing is copied on the original sheet in different colored inks or pencils.

If so desired, instead of tracing the outline of the lesion on the plastic plate and then transferring this outline to thin semi-transparent paper, the outline of the lesion can be traced directly over a sheet of transparent paper or other material placed on the plastic plate.

With the tracing device herein described a full size exact tracing of any lesion can be made without contact with the lesion. These tracings are useful in evaluating treatment and can be kept as permanent records for the patient's file. The tracings can be measured with a scale, and, in addition, the surface area of the lesion can be determined by use of a planimeter.

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.·. EDITORIALS .·.

DIATHERMY AND PERIPHERAL CIRCULATION

The recent emphasis on fundamental research in physical medicine has opened for re-examination some of the empirical practices utilized for many years by members of the medical profession. Certain principles based on casual observation may in the future be found incorrect in whole or in part when subjected to the scrutiny of controlled experimental observation. It is not to be expected, however, that at the onset all experimental workers will agree as to the results or the interpretation of results. The use of different technics under widely dissimilar conditions will certainly lead to results that may at first appear contradictory, but with further analysis may furnish information of a very fundamental nature. Such an apparent disagreement in results is found in this issue of the ARCHIVES.[1-2]

Using entirely different technics and experimental conditions. Kemp, Paul and Hines observed a decreased rate of blood flow in the femoral artery of anesthetized dogs during heating of the gastrocnemius muscle with short-wave diathermy. Wise, on the other hand, reports an increased blood flow measured plethysmographically in the human forearm while heated in a condenser or induction cable short-wave field. Anyone who has done experimental work in the field of peripheral circulation will realize the limitations of the methods used to measure blood flow in the two papers cited above. The regulating mechanism of the peripheral circulation is in such delicate balance that almost any instrument employed either in the anesthetized animal or the human alters the circulatory dynamics in such a manner that we are no longer dealing with a normal but a modified circulatory system.

The limitations of the bubble flow meter are adequately described by Kemp, et al. The dosage of diathermy, however, is an extremely difficult factor to control, particularly in the anesthetized animal. The distribution of the short-wave field may vary greatly with the geometric positioning of the limb and extreme caution must be observed in the anesthetized animal to avoid points of increased current density in a local area which may initiate pain reflexes and secondary circulatory vasoconstriction. The important observation is made, however, that in the dosages and conditions employed a diminished blood flow was observed in the femoral artery. It is possible that local changes of a small magnitude in the gastrocnemius muscle of the dog may not be accurately reflected in the femoral artery blood flow. It is of interest that the effects of cold, exercise, epinephrine and theophyllin on the peripheral circulation were of far greater magnitude than the short-wave diathermy.

The circulatory effects of microwaves are clearly demonstrable in the increased blood flow recorded in the femoral artery and vein. We feel, however, that a comparison between the circulatory effects of the shortwave and microwaves is not fully justified on the basis of the evidence given. As can

1. Kemp, C. R.; Paul, W. D. and Hines, H. M.: Studies Concerning the Effect of Deep Tissue Heat on Blood Flow, Arch. Phys. Med. 29:12 (Jan.) 1948.
2. Wise, C. S.: The Effect of Diathermy on Blood Flow. Plethysmographic Studies, Arch. Phys. Med. 29:17 (Jan.) 1948.

S

be observed in the appropriate tables, the gastrocnemius muscle temperature in the short-wave diathermy experiments was elevated from an average of 37.07 C to 39.8 C (an average increase of only 2.7 C), whereas in the microwave experiment the average tissue temperature before treatment of 38.09 C was increased to 42.44 C (an average increase of 4.5 C). It is quite possible that measurable vascular responses may not be demonstrable in instances where the tissue temperature deviates only slightly from the normal. The highly interesting qualitative differences between the two types of radiation await further study.

In the article by Wise certain difficulties encountered in the previous paper were avoided, but again we must be aware of the limitations of the plethysmographic method of blood flow recording. The use of dosage controlled in a clinical manner on unanesthetized human subjects is of importance. However, the plethysmographic apparatus in immediate contact with the forearm within the diathermy field might appreciably alter the distribution of energy within the arm. It is unfortunate that in these studies skin temperature and deep temperatures were not made available. The plethysmograph measures the arterial inflow to the segment of the limb contained within it and within the electromagnetic field. This has certain advantages over measuring flow in large arteries proximal to the warmed segment. Like the bubble flow meter, however, the plethysmographic method gives us no information as to whether the increased flow is in skin, subcutaneous tissue, muscle or bone. It is also well to point out the many technical sources of error in all plethysmographic studies and at best the results represent only a semi-quantitative observation.

In summary, then, we are confronted with evidence indicating that under widely different conditions short-wave diathermy may have totally different effects on the peripheral circulation. It may be well to insert a word of caution as regards clinical or therapeutic inferences from any preliminary laboratory studies. It is suggested to all those employed in fundamental laboratory studies that adequate emphasis of the limitations of the methods employed is essential if one is to avoid too hasty conclusions by the casual reader. We must await further observations under more controlled conditions which may clarify the subtle differences in responses of the various portions of the peripheral circulation to electromagnetic radiation.

THE SEMINAR IN NEW YORK

The Seminar on the Progress of Physical Medicine, held from December 1 to 3 at the New York Polyclinic Medical School and Hospital, afforded an excellent opportunity for a comprehensive review of modern thoughts in physical medicine. The material covered the entire field and was presented by masters of their subjects from all parts of the country. The enthusiastic response of the large audiences indicated the appreciation of the practitioners from all parts of the East, among them a large representation from the Veterans Administration and the Army. The verbal and written comments were numerous and flattering.

The program was opened by the remarks of Dr. Orrin S. Wightman, Consulting Physician at the Department of Internal Medicine of the Polyclinic and Chairman of The Board of Trustees of the New York Academy of Medicine. The presentations the first day centered chiefly about methods and included Microwave Heating: Gordon Martin, Rochester, Minn.; Low Frequency Muscle Stimulation: Richard Kovács; Fever Therapy: William Bierman; Exercise Therapy: Kristian G. Hansson; Rehabilitation of Crippled Children; Alfred R. Shands, Wilmington, Del.; Ion Transfer: Karl Harpuder;

Ultraviolet Radiation: William T. Anderson, Jr., Newark; Hypothermy: Frederick M. Allen; American Spas: Walter S. McClellan, Saratoga Springs and Occupational Therapy: Winfred Overholser, Washington, D. C. The program of the second day related chiefly to clinical uses and included Painful Feet: Jerome Weiss; Painful Shoulders: Bror S. Troedsson, Orange, N. J., Low Back Conditions: Frank R. Ober, Boston; Infantile Paralysis: Robert L. Bennett, Warm Springs, Ga.; Neurologic Conditions, Arthur L. Watkins, Boston; Peripheral Vascular Disease: Karl Harpuder; Geriatrics: Hans J. Behrend; Gynecology: Madge C. L. McGuinness; Dermatology: Anthony Cipollaro; Arthritis: Russell L. Cecil; Otolaryngology: W. Wallace Morrison. The program of the third day included Hospital Work: Walter J. Zeiter; Cleveland; Veterans Administration: A. Ray Dawson, Washington, D. C.; Civilian Rehabilitation: Howard A. Rusk; Athletic Injuries: Herman J. Bearzy, West Point; Electrosurgery in Urology: Joseph McCarthy; Physical Medicine in Army Hospitals: Emmett M. Smith and Benjamin A. Strickland, Jr., Washington, D. C.; Compensation Work: David J. Kaliski; Status of Physical Therapists: Mildred Elson; American Registry of Physical Therapy Technicians: Marion G. Smith, Chicago; General Practice: George M. Piersol, Philadelphia; Biophysics and Medicine: Kurt S. Lion, Boston.

The program concluded with a dinner meeting of the New York Society of Physical Medicine and the presentations: Physics of Atomic Energy: Howard A. Carter, Chicago and Clinical Applications of Atomic Energy: Frank H. Krusen, read by Gordon Martin; both papers discussed by Kurt Lion. During the following two days, prearranged visits to hospitals, such as the new Department of Physical Medicine and Rehabilitation at Bellevue, the Hospitals for Special Surgery, for Joint Diseases and Montefiore, enabled observations of technics as well as additional presentation of the value of applied therapies.

A highlight of the Seminar was the appearance of Mr. Bernard Baruch at the afternoon session of the third day, when he gave one of his cogent, incisive presentations for which he is famous. He said that his interest in physical medicine was due to the pioneering work in hydrotherapy of his father, Dr. Simon Baruch, and recalled that his father gave demonstrations of the subject at the Polyclinic Hospital during World War I, and stated he was greatly pleased to see the progress made. A cabled message of greeting was also received from Sir Morton Smart at London.

The entire Seminar was planned and executed by Dr. Richard Kovács, to whom all credit is due for an unusually effective presentation of modern physical medicine. His witty and inimitable introduction of the speakers was responsible for the continuity of the enthusiasm of the audience from speaker to speaker.

WILLIAM BIERMAN, M.D.

MEDICAL NEWS

Pennsylvania Academy of Physical Medicine

A meeting of the Pennsylvania Academy of Physical Medicine was held Nov. 20, 1947, at the Philadelphia County Medical Society Building, Philadelphia, Pa., and the following papers were delivered: Dr. Charles L. Chappell, "The Effect of Fetal Position in Some Congenital Deformities"; Dr. Harold Lefkoe: "The Treatment of Congenital Foot Problems," and Dr. Albert Martucci: "The Treatment of Congenital Torticollis."

New Journal

Hospital Administration Review, Northwestern University, is a new magazine, Malcolm G. MacEachern, M.D., Editorial Director, appearing quarterly. This publication is a service to the hospital field made possible by a grant from the Johnson and Johnson Research Foundation.

Among those on the Advisory Council are: George Bugbee, Executive Director, American Hospital Association; Dean Conley, Executive Secretary, American College of Hospital Administrators, and Everett W. Jones, Vice-President, The Modern Hospital Publishing Company.

Training in Physical Medicine

The U. S. Public Health Service has arranged for the training of medical officers in physical medicine preparatory to developing a more effective program of physical and occupational therapy for the rehabilitation of its legal beneficiaries.

Length and Location of Course. — Initially the training will consist of a six months course at the Massachusetts General Hospital in the Department of Physical Medicine.

Nature of Course. — The course will be both theoretical and practical and will include:

1. Orientation in physical medicine through study of the basic principles underlying physical and occupational therapy.

2. Training in technics through lectures, assigned reading and seminars.

3. Supervised practice in the use of apparatus and the application of methods and technics.

4. Instruction in writing prescriptions for treatment following the observation of cases in the department, making of ward rounds, examining patients, observing progress and response of patients and the preparation of case summaries.

Cases will include the various medical, surgical, traumatic, orthopedic, neurologic and arthritic types found in a general hospital. In addition, trainees will participate in the day to day work of rehabilitation clinics. Approximately 80 per cent of the course will be practical work.

Qualifications for Training. — Those volunteering must have had at least four years intensive clinical work in preparation for their specialty boards.

Subsequent Assignments. — On successful completion of the course officers will be assigned to Marine Hospitals in charge of programs of physical and occupational therapy.

Application for Course. — Any medical officer interested in taking the course should so advise the Surgeon General, making his communication for the attention of the Chief, Division of Commissioned Officers. The communication in every case should state when the officer would like to take the training if he has any preference as to time.

W. P. Dearing,
Medical Director,
Chief, Division of Commissioned Officers.

Testimonial Dinner to Dr. Sensenich

A testimonial dinner in honor of Dr. Roscoe L. Sensenich, President-Elect of the American Medical Association, was held at the Indiana Club, South Bend, under the auspices of the St. Joseph County Medical Society, of which he is a member. Dr. Harold D. Pyle, president, presided. The after dinner address was given by Dr. Morris Fishbein, Chicago, on medical statesmanship. Dr. Robert B. Sanderson, South Bend, presented a scroll to Dr. Sensenich.

Research in Multiple Sclerosis

Contribution of $25,000, made by Mrs. Percy S. Straus, New York, has been announced by the Association for Advancement of Research on Multiple Sclerosis, Inc. With this contribution the initial goal of $100,000 for research on multiple sclerosis has been met. The first grant made by the association was for $64,350 for work in the field of allergy.

Conference on Rheumatism

The second International Scientific Conference of Aix-les-Bains will take place by the end of 1948. It will be devoted to degenerative rheumatism; thirty-two reports by French and foreign specialists will be presented. For information, apply to: Dr. F. Francon, 9 Rue Lamartine, Aix-les-Bains.

Appoint Head of Department of Biophysics

Allen F. Reid, Ph.D., former director of Columbia University chemical and radioactivity research for the Manhattan Project in New York City, has joined the faculty of Southwestern Medical College, Dallas, as associate professor and

chairman of the college's department of biophysics. He will also serve as biophysicist at Baylor University Hospital in Dallas. At the college he will initiate a biophysical cancer research program, part of which will be sponsored by the American Cancer Society. Formerly he was on the faculty of the University of Chicago.

Hospitals Merge to Form Medical Center

The merger of Mount Sinai Hospital, Los Angeles, and the Los Angeles Sanatorium at Duarte has been completed to form the Mount Sinai-Duarte National Medical Center. Directors of the hospitals will serve as associate directors in the same capacities they held previously. The Los Angeles Sanatorium has provided free care for the tuberculous poor since 1913, while Mount Sinai Hospital has been active since 1920 in caring for those suffering from chronic ailments. The Mount Sinai Clinic has offered additional services to the Los Angeles needy.

New Jonas Policy Re: Publications and Visual Aids

Publications: The advisory committee of the Joint Council on Orthopedic Nursing has recommended a change in policy for distribution of reprints and handbooks available from the Joint Orthopedic Nursing Advisory Service (Jonas)

Limited quantities will be given free for reference libraries in nursing schools, public health agencies, physical therapy and occupational therapy schools. Instructors may obtain single copies without charge for their use in teaching and staff education programs.

Quantity orders of handbooks and articles reprinted from nursing journals (*American Journal of Nursing and Public Health Nursing*) and single copies will be for sale. Write to the Joint Orthopedic Nursing Advisory Service, 1790 Broadway, New York 19, for list of publications and prices.

In accord with the National Organization for Public Health Nursing policy, single copies of articles reprinted from *Public Health Nursing* are free to members.

Hitherto all Jonas materials have been free since the service has been entirely supported by an educational grant from The National Foundation for each year for the past three years and because printing costs have greatly increased, the proportion of the budget spent on this aspect of the service is excessive. Other Jonas activities such as field service must be curtailed unless a plan for financing publications is developed. The committee believed that this new policy would not deprive nurses of these materials and that they would gladly pay a modest charge for publications for their personal use.

Visual Aids: There is no charge in policy regarding the loan of slides without charge except for return postage. Agencies desiring to purchase slides may now do this directly from Jonas.

The Joint Orthopedic Nursing Advisory Service is glad to announce that the Posture Fundamentals packet (43, 8x10 inch illustrations of body mechanics of nurse and patient) may now be purchased for $1.00. Hitherto this has been available in restricted quantity for use of the instructor in a school of nursing or public health agency.

Walter Zeit to Head of Department of Anatomy

Walter Zeit, Ph.D., who has been an associate professor of anatomy at Marquette University School of Medicine, Milwaukee, since 1943, has been appointed director of the department to succeed the late Dr. Eben J. Carey. Dr. Zeit received his Ph.D. degree from Marquette University in 1939 and has been on the staff of the School of Medicine since 1921, having been an assistant in anatomy as an undergraduate.

Recess Appointments

The Surgeon General of the Army, Major General Raymond W. Bliss, announces that the President of the United States has tendered recess appointments in the Woman's Medical Specialist Corps, Regular Army, to the following physical therapists whose names appear on the second list of appointees in this new corps.

Public Law 36, 80th Congress, April 16, 1947, authorizes the establishment of a Women's Medical Specialist Corps to be comprised of a Dietitian Section, a Physical Therapist Section, and an Occupational Therapist Section. Officers in this corps enjoy all the benefits and privileges which are applicable to male commissioned officers of the Regular Army.

Almquist, Mary E.	1st Lt.
Amizich, Amelia D.	1st Lt.
Anderson, Mildred Jane	1st Lt.
Bender, Catherine M.	1st Lt.
Bradley, Ruth W.	Captain
Davison, Frances H.	1st Lt.
Ehrhart, Katherine C.	1st Lt.
Ellinger, Ruth W.	Captain
Engsberg, Mae A.	2nd Lt.
Frost, Virginia L.	1st Lt.

New Contour Applicator

Announcement is made by Burdick of their new contour applicator which is interchangeable with flat drum or cable. According to recent information released on those diathermies where a flat drum has been used, the contour applicator fits the adjustable arm now on the diathermy. The new applicator offers construction in five hinged sections to provide greater flexibility and also has a flexible inner plastic which smoothly covers the inner face of the applicator and follows body contours easily.

John U. Giesy

It is with regret we announce the passing of Dr. John U. Giesy of Salt Lake City, Utah, who held life membership in the American Congress of Physical Medicine.

BOOK REVIEWS

PHYSICAL MEDICINE IN GENERAL PRACTICE. By *William Bierman,* M.D., Attending Physical Therapist, Mount Sinai Hospital, Assistant Clinical Professor of Medicine, Columbia University. With a chapter on Medical Rehabilitation by *Sidney Licht,* M.D. Second edition, revised and enlarged, Fabrikoid. Price, $8.00. Pp. 686 with 310 illustrations. New York and London: Paul B. Hoeber, Inc., Medical Book Department of Harper and Brothers, 1947.

This second edition of Dr. Bierman's book most welcome. World War II has been fought and won in the interval between the publication of his first and second volume. A great impetus was again given to physical medicine as the result of the war, and not the least contribution was the development of rehabilitation. This concept of placing a patient back as an efficient member of society is going to have a tremendous influence on civilian medical practice. Dr. Licht has written an excellent chapter on this subject. Dr. Bierman states he has endeavored to incorporate the new advances including such subjects as the combination of penicillin and fever therapy. The author has written primarily for the general practitioner, and the physician in general practice will find the book useful as well as authoritative. The physiatrist will also find the book a most valuable mine of information. There are excellent chapters on hydrotherapy, climatotherapy and spa treatment, conventional and short wave diathermy. The subjects of massage, exercise and occupational therapy are adequately discussed.

The latter half of the book discusses the place of physical medicine in the treatment of disease related to the various systems of the body, such as locomotion, neurological, cardiovascular, genitourinary, eye, ear, nose and throat, digestion, gynecology, respiration and dermatology. The book is written in clear, concise language so that those who are not specialists in this field can readily grasp the material presented. This volume deserves a place in the library of anyone interested in the field of physical medicine.

DANIEL COIT GILMAN, CREATOR OF THE AMERICAN TYPE OF UNIVERSITY. By *Abraham Flexner.* Cloth. Price, $2.00. Pp. 164. New York: Harcourt, Brace & Co., 1946.

"First to create and organize in America a university in which discovery and dissemination of new truths were conceded a rank superior to mere instruction, and in which the efficiency and value of research as an educational instrument were exemplified in the training of many investigators," were the words used by Woodrow Wilson in 1891 to describe the academic pattern inaugurated by Doctor Gilman at the Johns Hopkins University.

Doctor Flexner outlines in this small book the evaluation of higher American education and brings out the important part Doctor Gilman played in this changing order. Even in his early life Doctor Gilman gave evidence of traits that would destine him as one of the really great American educators. However, it was not until 1875, when he assumed the presidency of the Johns Hopkins, that his genius was demonstrated. It was in that institution that he was able to put into effect his ideas of a university. They were new to America and fortunately for him and the future of American education they were not obstructed either by critics or lack of financial support.

More emphasis is devoted to the development of the graduate and undergraduate school but sufficient attention is given to the medical school to show how it was influenced by this new spirit. Here, too, recognition and stimulus was given to "research, inquiry and publication." The failure of Doctor Gilman to be bound by tradition created a medical school that soon attracted national and international attention. He had that rare ability to select men who added prestige to the institution. One of his earliest appointments was Doctor John Shaw Billings who was called to Baltimore to advise on medical education for the school and on the construction and equipment of the hospital. The names of other clinicians, surgeons, pathologists and others who joined the staff in those early formative years are illustrious and well known.

The book is interesting not only in telling of the association of Doctor Gilman and the Hopkins but more significant in showing how the better American educational institutions were revolutionized by this university which he established.

THE PHYSICO-CHEMICAL MECHANISM OF NERVE ACTIVITY. By *David Nachmansohn, Charles M. Berry, Oscar Bodansky, Frank Brink, Jr., Detlev W. Bronk, M. Vertner-Brown, C. W. Coates, R. T. Cox, J. G. Eccles, Alfred Fessard, J. F. Fulton, R. W. Gerard, Alfred Gilman, D. E. Green, Joseph C. Hinsey, Rudolph Hoeber, Martin G. Larrabee, and Tracy J. Putnam.* Reprinted from the Annals of the New York Academy of Sciences, Vol. XLVII. Paper. Price, $3.00. Pp. 375-602. Published by the New York Academy of Sciences, Central Park West at 79th Street, New York, N. Y., Dec. 15, 1946.

This conference was obviously set up to discuss and evaluate the role of acetylcholine in the mechanism of the conduction of the nerve impulse and across the synapse. Nachmansohn gives all the evidence which was available at the time of this conference in favor of the theory which ascribes a major role in the conduction to acetylcholine and acetylcholinesterase.

Considerable attention was paid to the effect of di-isopropyl fluorophosphate (DFP), which at the time of the conference was a new and controversial subject. The function of this drug is to eliminate the effect of acetylcholinesterase. It is of importance to know whether a nerve which has been treated with excess DFP will, or will not, conduct a nerve impulse; the acetylcholine theory requires that it will not. Electric hypotheses on nerve conduction would assume that the nerves soaked in DFP will still conduct impulses. Experimental evidence at the time of this conference was highly controversial.

One of the most challenging contributions to this symposium is the article by Eccles, of New Zealand, on An electrical hypothesis of synaptic and neuromuscular transmission. This hypothesis is based on three initial assumptions: first, that there is a highly resistant transverse membrane at the synapse; second, that the surface membrane at the synapse has the general electrical properties which are known for peripheral nerve and muscle membranes; third, that the synaptic region of the postsynaptic cell has unique electrical properties. This is expressed in the development of the graduated local response which is set up by cathodal polarization. On the basis of these three assumptions, Eccles has worked out a complete hypothesis of the neuromuscular junction.

Particularly useful has been the work in recent years on the ephapse, an artificial synapse. These artificial synapses can be made by approaching a nerve with another nerve and cutting the second nerve at the place where it approaches the first. These artificial synapses have physiologic properties which are entirely parallel to those which have been found in true synapses such as the neuromuscular junction or the synapses in ganglions or the central nervous system. These ephapses have the advantage that the electrical disturbances which occur can be analyzed much more closely than they can in the natural synapse. One of the problems that can be easily explained on the basis of a chemical transmission theory is the oneway conduction of the synapse. In the case of the neuromuscular junction, for instance, the nerve impulse is normally conducted from nerve to muscle, but only in abnormal circumstances can an impulse be conducted from the muscle to the nerve. If a nerve produces a chemical substance which stimulates the muscle, while the reverse is not true, this oneway conduction is easily explained. In the electrical theory, both the nerve and the muscle produce action currents, and it is not quite as easy to see that, while the nerve action potential is able to stimulate the muscle, the action potential of the muscle would not be able to stimulate the nerve. It has become clear in recent years that the explanation of the oneway conduction on the basis of the electric theory should be based on a careful study of the spread of the potential field surrounding the active nerve and muscular fiber. Another important question which Eccles analyzes is the synaptic delay, i. e., the delay between the arrival of the impulse at the synapse and the setting up of the impulse in the postsynaptic organ.

An important contribution is the article by Brink, Bronk and Larrabee, of the Johnson Research Foundation of the University of Pennsylvania, on Chemical excitation of nerve. They discuss rhythmic impulses obtained when the nerve is deprived of its calcium supply. Among the interesting phenomena which are brought forth in this article is the relation between rhythmic local responses and rhythmic propogated responses and the meaning of changes in frequency which are observed under different experimental conditions. The authors show that if they plot the intervals between adjacent impulses instead of the frequency of the impulses, these intervals do not show a random variation but certain specific intervals are favored. These intervals are of the order of magnitude of 3, 6, 12 and 18 milliseconds. Apparent changes in the frequency of impulses have to be explained not by gradual changes in the frequency of the impulses but in the occurrence of larger numbers of shorter intervals and a decrease in the number of the longer intervals. The authors come to the conclusion that there might be a basic frequency of about 300 cycles per second in the functioning of nerves. This frequency is of the order of magnitude of data which have been obtained by other authors and with entirely different methods. Bodansky and Gilman, of the Medical Division of the Chemical Warefare Service, Edgewood Arsenal, discuss cholinesterase and the effects of drugs on nerve activity. An excellent discussion of the original work with DFP is found in these papers.

This book forms one of the most challenging contributions to the problems of physiology of nerve which has appeared in recent years.

MUSCULAR CONTRACTION. By *Alexander Sandow, R. S. Bear, Ernst Fischer, A. S. Gilson, Jr., Eugene Guth, G. E. Hall, M. A. Jakus, S. W. Kuffler, Otto Meyerhof, Severo Ochoa, Robert W. Ramsey, F. O. Schmitt, G. M. Schoepfle, Shih-Chang Seng, H. Burr Steinbach,* and *S. M. Walker.* Reprinted from the Annals of the New York Academy of Sciences, Vol. XLVII, pp. 665-930, May 30, 1947. Paper. Price, $3.00. Published by the New York Academy of Sciences, Central Park West at 79th Street, New York, N. Y., May 30, 1947.

Part I contains four articles: the first, on the dynamics of single muscle fibers, by Ramsey; the second, on the time course of tension development in muscle response, by Gilson, Schoepfle and Walker; the third, on muscular contraction and rubberlike elasticity, by Guth, and the fourth, on the membrane changes during excitation and inhibition of the contractile mechanism, by Kuffler. The second part of this symposium, on ultrastructure, contains an article by Ernst Fischer of the Medical College of Virginia on birefringence and ultrastructure of muscle and an article by Schmitt and his collaborators from the Massachusetts Institute of Technology on electron microscope and x-ray diffraction studies of muscle structure. The

article by Schmitt, Bear, Hall and Jakus on electron microscopic and x-ray diffractions data of muscle is of particular importance, even though much of the material is still preliminary. Part III discusses the chemistry of muscle in two articles: one on the main chemical phases of the recovery of muscle by Meyerhoff, and the other on the chemical processes of oxidative recovery by Severo Ochoa. Particular attention has been paid in these articles to the relation of adenosine triphosphate and myosin. The important relationship of muscle chemistry to changes in muscle volume is explained. Part IV of the symposium discusses the problems of mechanochemical coupling. H. Burr Steinbach discusses the intracellular inorganic ions and muscle action, and Shih-Chang Shen discusses the interaction of myosin and adenosine triphosphate in greater detail. A particularly interesting chapter is the discussion by Shen on the theories of muscular contraction and relaxation.

In the final article, Alexander Sandow, the consulting editor and moving spirit behind this conference, discusses his work on the so-called latency relaxation.

This symposium is undoubtedly one of the most significant publications in the field of muscle physiology that has appeared in recent years.

SIGNS AND SYMPTOMS, THEIR CLINICAL INTERPRETATION. By *Cyril Mitchell MacBryde,* A.B., M.D., F.A.C.P., Assistant Professor of Clinical Medicine, Washington University School of Medicine; Assistant Physician, Barnes Hospital, St. Louis, Mo. Cloth. Price, $12.00. Pp. 398, with 74 illustrations and 6 colored plates. Philadelphia, London, Montreal: J. B. Lippincott Co., 1947.

This is not a text book on medicine and it is not the type of book, as the title might imply, that lists the various signs and symptoms alphabetically or by regions and from which a physician hopes to make a selection for a diagnosis. It is a different kind of medical book which should appeal to the more intelligent physicians whether they are general practitioners, internists, surgeons or other specialists. There are 27 chapters by renowned clinicians and include such topics as backache and back pain by Freyberg, fainting by Stead, dyspnea and cyanosis by Barr, edema by Barry Wood, anorexia, nausea and vomiting by Horner, nervousness and fatigue by Gildea, fever by Beeson, obesity by MacBryde, abdominal pain by Sara Jordan and the others. Each chapter covers the subject, not in a systematic listing of symptoms but in a rational physiologic manner with clear interpretation of these various symptoms.

As an example in the chapter on pain in the extremities by Williams, the material is discussed in the following way: the perspective of the problem with a consideration of the anatomic, psychiatric and metabolic basis of pain; the nature and causation of pain in the skin, muscle, bone, joint, etc.; the false localization of pain as shown by the radicular, spinal cord and cerebral syndrome; the evaluation of painful sensation as to severity, quality, localization, duration, duplication, etc., and finally a summary. Doctor Williams does consider specific diseases and disorders but in a more general manner. The other chapters are handled similarly.

The emphasis is on symptoms and how they aid in making the diagnosis. It is not a book to make the diagnosis easy for any specific case but can best be compared to the Osler method of teaching in which a subject is studied thoroughly and thus aids in establishing a pattern. This eventually is the more helpful and makes for an unusual physician or clinician. If medical students were taught to think of dysfunction of bodily systems in terms of pathologic physiology as demonstrated in this book, medical school days would be more profitable and less tedious. The chapters make good reading and something to stir the intellect.

FRACTURES AND DISLOCATIONS. By *Kenneth M. Lewis,* B.S., M.D., F.A.C.S. Assistant Clinical Professor of Surgery, New York University College of Medicine; Surgeon to the University Medical Office, Columbia University; Adjunct Professor of Surgery, New York Polyclinic Medical School; Associate Visiting Surgeon, Bellevue Hospital; Assistant Visiting Surgeon, Polyclinic Hospital; Member New York and Brooklyn Regional Fracture Committee, American College of Surgeons; Fellow of the American Association for the Surgery of Trauma. Cloth. Price, $2.00. Pp. 217. New York: Oxford University Press, 1941.

This member of the Oxford Medical Outline Series is intended to be used for quick reference in the teaching of fractures. The first seven chapters, comprising a total of only thirty-two pages, present the fundamentals of fractures, including a definition of terms, diagnosis of fractures, stages of bone repair, causes of non-union, principles of emergency and permanent treatment of fractures, fractures in children and pathologic fractures. The remaining fifteen chapters cover the specific types of fractures most commonly encountered. Each chapter is devoted to a separate section or joint of the body. Under each fracture, the important factors in etiology, pathology, diagnosis, treatment and prognosis are outlined.

The author has attempted to omit all controversial detail and to include only the most universally accepted methods of fracture treatment. When several methods may be equally good, all are covered in the outline. The author stresses the simpler methods of fracture treatment; open reduction and internal fixation is usually given second choice. On the whole, the author's choice of treatment is the one most commonly employed by the experienced orthopedic surgeon. His use of the banjo splint and the tongue blade splint in the treatment of hand fractures, however, has been proved to produce much more residual stiffness in the small joints of the fingers than treatment of these fractures by other methods.

The physiatrist will find this text a handy ref-

erence in evaluating the treatment of a specific fracture. Although the author does mention the use of physical therapy in the management of many fractures, he probably does not stress the importance of this treatment as much as he might.

MENTAL MISCHIEF AND EMOTIONAL CONFLICTS. PSYCHIATRY AND PSYCHOLOGY IN PLAIN ENGLISH. By *William S. Sadler,* M.D., F. A. P. A., Consulting Psychiatrist, Columbus Hospital, Chicago. Cloth. Pp. 396. Price, $6.00. St. Louis: C. V. Mosby Company, 1947.

Since more than 75 per cent of all persons examined at the larger medical centers of this country are found to be suffering from some functional nervous disorder or emotional conflict, there exists a real need for books such as this which contain practical information for the layman concerning mental hygiene. This book is written to enlighten the average person who suffers from a functional nervous disorder or in whose immediate family there are victims of emotional conflicts.

There are few books that offer anything like so thorough going a review of the whole field of the so-called neuroses and some of the more commonly encountered psychoses. This book in addition to discussing thoroughly the neuroses also considers those manifold miseries which are embraced within the general category of psychasthenia, neurasthenia, hysteria and the allied functional nervous disorders. The discussions are all in plain English and can be recommended to the layman.

MEDICAL DISORDERS OF THE LOCOMOTOR SYSTEM, INCLUDING THE RHEUMATIC DISEASES. By *Ernest Fletcher,* M.A., M.D. (Cantab.), M.R.C.P., Physician to the Arthritic Clinic and Lecturer on the Rheumatic Diseases, Royal Free Hospital; Physician, Queen Mary's Hospital for the East End and the British Red Cross Clinic for Rheumatism; Consulting Physician to the British Legion; Heberden Medallist and Lecturer in Rheumatism; Member of the Research and Scientific Advisory Committees, Empire Rheumatism Council; late Physician-in-Charge of a Medical Division, Emergency Medical Service, Ministry of Health; Consulting Physician to the Kent County Council. Cloth. Price, $11.00. Pp. 616, with 262 illustrations. Baltimore: The Williams & Wilkins Co., 1947.

The British for centuries have contributed a tremendous amount of valuable medical information about the rheumatic diseases. Their publications in book form, monographs and numerous other sources have been most important and pertinent. The six years of war left a great void. This work of Dr. Fletcher, an outstanding authority on rheumatic diseases, is one of the first major works to appear since the war.

The work covers all the subjects included under the term rheumatism and rheumatic fever and in addition short chapters are devoted to medical diseases of bone, peripheral vascular diseases and a chapter entitled, Miscellaneous lesions mentions everything from Bell's palsy to paroxymal proctalgia.

A chapter on applied anatomy considers the various joints as to anatomy and function and is both an unusual and a worth while inclusion for this type of book. The author states that "an adequate knowledge of the gross anatomy of the bones and muscles is possessed by most physicians" which may apply to the British physicians but certainly not to enough American practitioners.

The physiology of the joints is fairly complete and understandable and the consideration of the clinical features in all its aspects of the rheumatoid arthritis, osteoarthritis (degenerative joint disease), gout and spondylitis conforms with the accepted concepts of these diseases and is presented in a clear and comprehensive manner. The emphasis that the author places on foci of infection is not in agreement with the view held in this country at the present time. Most rheumatologists here agree that any infection is a potential handicap but that eradication of the various foci is likely to bring about a cure has not been borne out except for the specific infectious arthritis.

This book is likely to be disappointing to persons interested in physical medicine because of the author's apparent lack of appreciation of the possibilities of this subject and his recommendation of various measures which are not rational or physiologic and which have been found to be ineffective when evaluated objectively. Although in the last chapter on physical therapy the author does give credit to the value of these measures in the care of patients with disorders of the locomotor system, certain statements are made in this chapter and in other sections of the book which should stun any physiatrist. As examples in the discussion of the treatment of rheumatoid arthritis a half of a page is devoted to physical therapy and the following quotation is made: "almost the whole range may be used at one time or another, but two measures are of outstanding importance" and these are "general superficial massage and ultraviolet light"; and in the few paragraphs on physical therapy for osteoarthritis these statements are made: "heat and massage with passive movements do not produce the improvement that might be expected," "diathermy is *unexpectedly* (italics the reviewer's), helpful," "faradism has a definite place." As to ankylosing spondylitis "the Kromayer lamp has a large and sometimes it seems decisive place in treatment" and for calcifying tendinitis of the shoulder, "diathermy has been recommended by some authors but on the whole does little good." One of the indications for terminating bed rest for a rheumatoid arthritic is "persistent constipation which does not yield to abdominal massage, mild aperients, and faradism to the abdominal muscles." In describing the use of the Kromayer lamp "the effect of the radiation can be increased by pressing the lamp surface hard on the skin so as to press out the blood from the vessels" and in colonic therapy "the only method of emptying the bowel mechanically

which relies to some extent on the patient's own effort is the Studa chair treatment and this is the treatment of choice." What is this Studa chair? These and other errors concerning physical medicine are regrettable in a work which on the whole is noteworthy because of the effort to avoid mistakes. The author has sought the aid of radiologists, anatomists, laryngologists and others to write the chapters on these particular subjects. With the numerous and illustrious physiatrists that are available in England, the author might have sought their advice and contribution for the chapter on physical medicine.

The book will be more helpful for the general practitioner for whom no doubt it is intended than for the specialist in rheumatology. It will appeal more to British readers than American since the terminology, medications and other discussions are British. His consideration of the arthritic disabilities is excellent and well proportioned and if the book were limited to these conditions it would be adequate and most satisfactory.

FUNCTIONAL CARDIAC DISEASE. By *Meyer Friedman,* M.D., Lieutenant Colonel, Medical Reserve Corps, U. S. A.; Director, Harold Brunn Institute for Cardiovascular Research, Mt. Zion Hospital; Instructor in Medicine, Stanford University Medical School, San Francisco, California. Cloth. Pp. 266, 14 tables. Price, $3.00. Baltimore: The Williams & Wilkins Company, 1947.

This book is a definite contribution toward the clarification of the confusion which exists in the field of functional cardiovascular disease. The author defines the condition as follows:

"Functional cardiovascular disease is a disorder in which (1) various involuntary (autonomic) actions, particularly those concerned with cardiovascular function, at times are poorly or only partially controlled, (2) Episodes of neurogenic activity spontaneously erupt and (3) pain states of neurogenic or psychogenic origin may occur, and (4) a partial recession of cortical activity takes place."

The author presents evidence that the underlying disorder is a cortico-hypothalamic imbalance.

In a thoroughly scientific manner, he analyzes the physiologic mechanisms of the various symptoms including the respiratory disorders, giddiness, palpitation, fatigue, anorexia, gastrointestinal symptoms and accompanying psychic disorders. He presents a hyper-ventilation test in which these patients exhibit less improvement in breath-holding ability after hyper-ventilation than normal persons.

The chapters on etiology and treatment are especially illuminating and present several new concepts. That portion of treatment termed moral rehabilitation was especially interesting to the reviewer. "The correct ideals for 20th century man still remain the 20th century's problem. Until they are found and fitted with the hot steel of emotional enthusiasm it is doubtful whether the incidence of psychoneuroses will decrease."

The book is highly recommended to all those interested in the field of cardiovascular disease.

YOUR RHEUMATISM AND BACKACHES. By *Joseph Wasserug,* MD. Cloth. Pp. 310. Price, $2.50. New York: Wilfred Funk, Inc., 1947.

This book presents to the lay reader complete, authoritative, understandable and definitely helpful discussions of these diseases which cause untold suffering to millions of victims. The author points out that rheumatism is not a disease. It is many diseases. One person's rheumatism may be another's gout, arthritis, neuritis or any one of numerous other specific ailments.

The author deals with each of these diseases, describes the symptoms, goes into enlightening detail on recent discoveries of science that have made treatment and relief more successful. A physician can feel safe in recommending this to a lay person to read.

THE TREATMENT OF IMPOTENCE WITH SPECIAL REFERENCE TO MECHANOTHERAPY. By *Joseph Loewenstein,* M.D., Honorary Psychotherapist, West End Hospital for Nervous Diseases, London. Foreword by Eric B. Strauss, D.M., F.R.C.P., Physician for Psychological Medicine, St. Bartholomew's Hospital, London. Cloth. Pp. 49. Price, 6 s. net. London, Hanish Hamilton Medical Books, 1947.

The author believes that the term mechanotherapy should be reserved exclusively for the treatment of impotence with supporting apparatuses for the penis. Other appliances are hardly worth mentioning and are interesting only from the historical point of view. It is pointed out that the failure of erection is of decisive importance for the development of impotence and that is, moreover, its most obvious symptom. The subject of this study is to show how this problem of secondary inhibition can, in many cases, be solved by the help of a mechanical support for the penis, i. e., mechanotherapy.

SCIENCE SINCE 1500: A SHORT HISTORY OF MATHEMATICS, PHYSICS, CHEMISTRY, BIOLOGY. By *H. T. Pledge,* Librarian, Science Museum of London. Cloth. Price, $5.00. Pp. 357, with illustrations. The Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1947.

This volume is a scholarly thesis on the development of science and it shows how the advancement in one branch of science is interwoven with the development of other branches.

The author has studied the history of mathematics, chemistry, physics and biology and his knowledge is indeed extensive. Yet withal he has kept the presentation within the limits of 357 pages. It treats with the difficulties encountered by the famous scientists while endeavoring to unlock the secrets of nature.

The book does not deal with therapeutics and is not so intended. Undoubtedly the physiatrist's interest in the book would be cultural. Every medical research worker should read it.

PHYSICAL MEDICINE ABSTRACTS

Care of the Long Term Patient Requires Careful Planning. David Littauer.

Mod. Hosp. 69:63 (Sept.) 1947.

Certain groups of long term patients, particularly those suffering from arthritis, spastic or flaccid paralysis or surgical conditions of the bones, joints and muscles, require extensive therapy by physical means.

This implies a more elaborate department than is normally required in the acute general hospital. A small gymnasium must be provided. In addition to the arm and leg whirlpools and the Hubbard tank, hydrotherapy must include a walk-about pool, with its movable hand rails and crane and sling.

Physical therapy for the convalescent recovering from an acute illness or operation is normally short-lived and simple and is directed by the registered physical therapist on the prescription of the attending physician or surgeon. The long term patient, however, is frequently a baffling clinical problem. In such cases, the medical scientist must seek the advice of a specialist in the modalities of physical therapy who also knows the physiology and pathology of the condition to be treated. Somewhere along the line of planning, therefore, a decision may have to be made in favor of a doctor of physical medicine over a registered technician.

The department of occupational therapy should be large enough to offer a variety of types of work to the long term patient, whether he can come to the workrooms or is confined to his bed. Looming of rugs, working with leather, book-binding, painting, carpentry and woodworking are activities which can occupy a patient's time, enable him to create something useful and in many instances as therapeutic devices to exercise atrophied or spastic muscles and stiffened joints. In larger hospitals an occupational therapy department could be combined with physical therapy into one department of rehabilitation.

The Problem of Cerebral Palsy.

Edit. J. A. M. A. 135:513 (Oct. 25) 1947.

Recent investigations support the original statement of Little that "the condition may present itself as a congenital affliction or as a result of diseases during infancy. Cerebral palsy is probably in most cases the result of variations in the structure of the brain." The abnormality may vary from the slightest physical handicap to subnormal mentality and severe physical disability with inability to meet the simplest personal needs. The misconception that the mental development of the patient with cerebral palsy is necessarily retarded needs correction. As a matter of fact, mentality is normal in most instances; whatever mental retardation is present is due to a lesion of the area of the brain concerned with the development nf intelligence. This occurs in a limited percentage of patients.

The report points out that the evaluation of the extent of physical and mental retardation is difficult even when the diagnosis of the condition is almost self evident. Evaluation requires determination of the type of qualitative motor defect, the degree of handicap, the parts of the body involved, the amount of involvement, the developmental progress that has been made, the presence of associated or independent defects and the social situation of the patient and the patient's family.

Proper diagnosis of cerebral palsy depends on the training of more medical specialists supplemented by psychologic examiners and specially devised testing and diagnostic procedures which are capable of reaching the real person through the mask of physical handicaps which stand between him and the examiner.

Treatment cannot eradicate the original lesion. Specific treatment can be given for some of the defects, but the patient must be trained rather than treated. Whatever latent resources he possesses can be actvated to the fullest extent. Training consists primarily of physical and occupational therapy to help the patient achieve better coordination of movements, to control hyperactive movements and to overcome involuntary movements through relaxation and similar functions.

Specialists estimate that 65 to 70 per cent of patients with cerebral palsy have normal mentality. Improvement in such patients extends from simply acquiring the capacity to dress and feed themselves to complete vocational rehabilitation.

The Clinical Aspects of Physical Medicine. A. E. White.

J. Michigan M. Soc. 46:677 (June) 1947.

It must be understood that physical medicine is a specialty, the same as other recognized specialties, and that the physiatrist has to be exceptionally well-grounded in anatomy, physiology, physics and neurology. He must continually be aware of the problem of the general practitioner, the surgeon, the internist, and the psychiatrist. He must be aware that kinesiology in its entirety is the difference between activity and vegetation.

Physical medicine embraces the fields of physical therapy, occupational therapy and physical reconditioning. Those who are engaged in the specialty of physical medicine believe that all patients are entitled to have their bodies and minds maintained in the best possible condition at all times. They do not wait until the surgeon, the

psychiatrist and the internist have finished treating the patient, but work simultaneously with them, thereby reducing the morbidity and returning the individual to productive society at an earlier date than could be expected otherwise.

It should be stressed that physical medicine is a recognized medical specialty that is closely associated with surgery and internal medicine, yet does not infringe upon either. As a general rule, the physiatrist aids the surgeon and internist in increasing the rapidity of recovery of their patients, or continues treatment after their services are no longer required.

The helpless and hopeless invalid who can be made financially self-supporting is a boost to humanity. It has already been proved that certain types of invalids of many years' duration can and have gained economic independence, with the aid of physical medicine.

Transition in Medical Education. Alan Gregg.

J. Am. Med. Coll. **22**:226 (July) 1947.

In other centuries, doctors described disease and gave their best attention to methods of curing it. But from 1870, the date is arbitrary, the constant quest has been for the cause. Etiology became, as it were, the husband of diagnosis and the father of treatment. There is a primary concern for the cause as perfectly natural. The author wonders if we do not exclude thereby some other important aspects of disease. He asks if we do not lose interest once the cause is known. Witness the atmosphere of the usual hospital for chronic disease. Witness the singular freshness of Howard Rusk's ideas on the possibilities of intelligent convalescent care. If clinical description and narration had been the major characteristics of the past eight decades we would have had more use for our chronic hospitals. We would have prepared in them complete natural histories of disease. If we had cared as much for therapy as for etiology, we should have little to learn from Rusk, instead of much.

Shoulder and Elbow Lesions Distinctive of Baseball Players. George E. Bennett.

Ann. Surg. **126**:107 (July) 1947.

The professional baseball player is a human being, not a superman and susceptible to all of the common lesions of the shoulder which we see in the non-ball player, namely, subacromion and subdeltoid bursitis, irritation of the supraspinatus and biceps tendons, traumatic synovitis and inflammatory disease. Fortunately, these conditions form the largest group and respond well to rest, heat and general orthodox treatment. Because a man is a ball player does not mean that he cannot have abscessed teeth, infected tonsils, or other ofci of infection; therefore, his general health should be thoroughly investigated, just as one does when in search of some obscure etiologic factor in joint lesions.

His occupation is such, however, that aside from these common joint complaints he develops distinctive lesions. One which has been definitely identified and, probably, is nonexistent in other occupations, is a deposit on the posterior and inferior margin of the glenoid fossa, on or about the attachment of the triceps tendon.

The second lesion is a fraying of the supraspinatus tendon, which the author does not think can be classed as distinctive, because one sees it in individuals engaged in other occupations. The constant snubbing of the supraspinatus tendon over the head of the humerus and the greater tuberosity results in a gradual fraying of the deeper structures of the supraspinatus tendon.

Backache and Fibrositis: A Medical Point of View. W. R. Caven.

Canad. M. A. J. **57**:37 (July) 1947.

The essential part of treatment is to stretch the tissues involved, by some means or other, by traction where that is possible or by firm massage directly on the tender nodules.

Before any manipulative treatment is undertaken it is wise to have roentgenograms made of the spine to rule out abnormal bone conditions and to be sure that the bones are not partially decalcified through old age and therefore fragile.

The treatment of the neck and shoulder areas, when they are involved, should be done first. The table or couch should be firm but not hard and the head end of it should not be raised. The patient is to lie flat on his back with the shoulders at the head end of the table and the head supported by the physician's left hand. The right hand is placed below the patient's chin and direct traction exerted. This should not be more forcible than is necessary to relax the neck muscles and there should be no suggestion of moving the patient's trunk by the pull. This steady traction should be continued for about one minute and may be repeated at the end of the other manipulations. Next the head is held firmly by a hand on each side and moved upward and toward the patient's feet while at the same time the face remains looking directly upward. This manoeuvre is easy to do but difficult to describe and it is a movement which can not be done voluntarily.

After the manipulation the patient should sit up and be given instructions about general care, and special exercises which he can carry out until seen again.

An Experiment in Rehabilitation. J. R. Napier; J. N. Barron; T. P. Gregory, and D. R. Thompson.

Brit. M. J. **4518**:203 (Aug. 9) 1947.

In regard to mobilization of stiff joints, much can be done in the department of physical medicine, where the skilled application of heat in the form of wax baths or ray treatment, combined with careful active and passive movements, is in the early stages of greater value than any of the industrial methods. On the other hand, a variety of industrial operations offer unrivalled opportunities for encouraging active mobilization of stiff joints through the improvement of muscle power transmitted over them.

Flexor-Tendon Grafts to the Finger and Thumb. Walter C. Graham.

J. Bone & Joint Surg. **29**:553 (July) 1947.

In a severely scarred finger, fusion of the distal interphalangeal joint is frequently preferable to an attempt to restore flexor-tendon function. If the finger has good sensation and good joint function, a flexor-tendon graft will restore useful function. The graft should be dissected out, to retain the gliding material on the tendon. The restoration of function requires constant effort on the part of the operator in the form of encouragement and personal supervision of the mobilization of the tendon.

Rate of Regeneration of Motor Fibers in the Ulnar and Sciatic Nerves. Sydney Sunderland.

Arch. Neurol. & Psychiat. **58**:7 (July) 1947.

An investigation of the rate of functional regeneration of motor fibers following interruption of conduction in the ulnar and sciatic nerves provided the following results: For the terminal section of the ulnar nerve in the hand, the rate of growth was 0.6 mm. per day after axonotmesis and 0.4 mm. per day after suture. For the section of the sciatic nerve just below the knee, the rate of growth after axonotmesis diminished from 2 to 1 mm. per day.

Support of the Paralyzed Face by Fascia. James Barrett Brown, and Frank McDowell.

J. A. M. A. **135**:18 (Sept. 6) 1947.

In paralysis of the facial nerve, the temporal muscle and its fascia can be used for supporting the drooped tissues of the face. For this the muscle is connected to the face by loops of fascia lata, and it can then straighten the deviated mouth and columella nasi and support them in the normal position. The nasolabial fold is often reformed, and a small amount of movement may be produced by the muscle which is controlled by the fifth cranial nerve.

The procedure does not disturb the patient much, does not impair the functions of other nerves or leave visible facial scars. Five or six days' hospitalization is recommended with an additional week of outpatient care.

Reablement of Children With Infantile Cerebral Palsy. Eirene Collis.

Lancet **6468**:239 (Aug. 16) 1947.

In the reablement of children with infantile cerebral palsy, paralysis is defined as inability to contract muscle for the reason that the muscle is completely cut off from nervous control. Cerebral palsy, on the other hand, is dysfunction of movement due to a cerebral lesion interfering with one or more of the several pathways directly concerned with normal human movement.

Training is instituted as follows, all measures overlapping to form a whole rehabilitation scheme: physical therapy, everyday activities, occupational therapy, speech therapy, school or kindergarten work.

Control of Interference Caused by Diathermy Equipment.

J. A. M. A. **134**:1486 (Aug. 23) 1947.

More than ten years ago the Federal Communications Commission was requested by radio communication agencies to formulate regulations to control the interference caused by diathermy equipment. On May 9, 1947 the commission released Public Notice No. 7722, which document assigned three frequency channels for medical diathermy. The channels are 13.66, 27.33 and 40.98 megacycles in arithmetic progression and correspond to wavelengths of 22, 11 and 7½ meters, respectively, in harmonic progression. The widths of the channels are approximately 15, 320 and 40 kilocycles.

A physician owning and operating a diathermy apparatus manufactured prior to July 1, 1947 may continue to operate for a period of five years, provided the equipment does not interfere with authorized radio services. If interference is reported, the physician is responsible for eliminating the disturbance to radio communications. This may be accomplished in some instances by readjusting the existing diathermy appliance. If no means can be provided to eliminate the interference, the physician becomes subject to the new rules and regulations. That is, he must screen his present apparatus or acquire frequency controlled equipment.

Rapid Postoperative Mobilization. Vincent D'Ingianni.

New Orleans M. & S. J. **100**:80 (Aug.) 1947.

Rapid mobilization quickens circulation, thus lessening the chances for stagnation, clotting, and pulmonary emboli. There have been no instances of emboli among the 700 patients on which this report is based. Early body motion after operation maintains muscle tone, which is highly desirable. Orthopedists recognize this fact; their trend is away from heavy casts which restrict motion and thus cause muscle atrophy. Motion prevents the accumulation of waste products in the tissues.

Rapidly mobilized patients do not usually need purgation or catheterization for their normal body functions are resumed early after regular motion is resumed. Pain and incisional discomfort which are often intense when a patient rises on the first or second postoperative day diminishes rapidly, if one is to judge by the number of injections of narcotics needed by the patients rapidly mobilized. The attitudes of well-being and of independence, which are inevitable sequellae of rapid mobilization, are indeed worthy of mention.

Nerve Injuries Affecting the Hand. Nils L. Eckhoff.

Clin. J. **2097** (July-Aug.) 1947.

Deep massage over a paralyzed muscle can only do harm. Light effleurage may be permitted to maintain mobility of the muscle fibers.

There is considerable difference of opinion over

the value of galvanic stimulation. Some maintain that it is harmful, others that it diminishes muscle wasting and aids recovery.

All agree that it is paramount to support paralyzed muscles to keep them from being stretched. Splints are designed for each type of palsy. For ulnar palsy the metacarpophalangeal joints must be kept flexed, to prevent harmful stretching of the intrinsics. For median palsy the thumb is held in front of the index metacarpal and then well abducted, to relax the opponens and short abductor. For radial palsy the wrist and metacarpophalangeal joints should be held in extension—but not the interphalangeal joints. The old fish server cock-up splint is an abomination, and I can think of no condition in which it is required. In radial palsy—or in burns—one has seen far too many hands ruined by keeping the fingers in extension, where they so rapidly get stiff, for which there is practically no cure.

Occupational therapy is designed specially for each type of palsy, and can well be executed with the splints in position.

Free Tendon Grafts in Secondary Flexor Tendon Repair. J. William Littler.

Am. J. Surg. **74**:315 (Sept.) 1947.

A common injury requiring the use of a free graft in secondary repair is the severed deep flexor tendon in the distal palm or proximal phalanx. The tendon is disrupted in the region of the proximal annular ligament where a primary suture frequently fails, unless it is done with the most exacting technic under favorable conditions. Several tendons complicated by fractures of the metacarpals or phalanges, as seen in crush and missile injuries, are repaired following union of the fractures, resurfacing if necessary and joint mobilization.

Good primary healing with a minimum of cicatrix is gained through immobilization. Early motion has no place in free tendon grafting, for not until three weeks have passed are the tendon junctures united. An untraumatized tendon will not adhere firmly to surrounding soft tissue if left undisturbed for this period. During the early postoperative phase, when the graft is swollen, softened and vascular, motion promotes the formation of scar and adhesions. The cicatricial index and reaction to injury varies in patients, and has some influence on the final functional result in tendon surgery.

At the end of three weeks the skin sutures are removed and the pull-out wire at the terminal phalanx is withdrawn. Passive joint exercises are carried out during the following three or four days and then active flexion is started. During the latter part of the fourth week the patient is instructed to hold firmly in extension the metacarpophalangeal joint, thus transmitting the pull to the proximal interphalangeal joint. If this is not done flexion will be gained only at the former joint. A gripping block made of soft wood 3½ by 1¾ by ⅝ inches is excellent for exercising the finger. Persistent active exercise is important in gaining good finger flexion.

Diagnosis and Management of Peripheral Nerve Injury. E. S. Gurdjian, and J. E. Webster.

Am. J. Surg. **74**:359 (Sept.) 1947.

Splints of affected parts are, in general, of little help in rehabilitation. The advantage of preventing overstretch of muscles is offset by the disadvantages of immobilization, resulting in inactivity of the affected muscles. The patient looks on the splint as a form of treatment and overlooks the insidious fixation of the joints and muscle atrophy; however, patients with dropped wrist, shoulder or foot should have the parts neutralized, especially during sleep.

The plan of rehabilitation for the patient with peripheral nerve injury must begin immediately after trauma. As early as possible the patient must be instructed and repeatedly advised regarding the importance of continuous physiotherapeutic exercise of the affected part. Instead of maintaining a passive role, an active, interested and cooperative viewpoint must be indoctrinated in the patient.

Any surgical procedure is but a single step in the treatment. A successful result also depends on continuing exercise performed through a period of months. The patient cannot simply be told to exercise his extremity. He should be taught the gross fundamentals of the anatomy and physiology of the involved part and the role of occupational physiotherapy. This can best be done by a therapeutist who with adequate facilities can teach and encourage progress. The facilities are simple devices which stimulate the patient to exercise and illustrate muscle movements which he in turn can imitate. It is of importance that the patient participates in the experiences and progress of those also employing the physiotherapy and occupational facilities. He can be impressed by seeing the retarded patient who neglected his hand or he can be stimulated by the progress of the cooperative patient.

The Effect of Electric Stimulation on Ocular Tension. P. B. Zaretskaya.

Am. J. Ophth. **30**:589 (May) 1947.

The mechanism of action of the galvanic current (cathelectrotonus and anelectrotonus) on the ocular tension is as yet not clear. It is possible that its effect on tension can be attributed to changes in the potassium calcium balance. These changes take place during electrization of living tissue and may lead to profound changes in the metabolism of the cell.

It is interesting to mention in this connection Zondek's work, which shows that the physiologic action of potassium is similar in effect to stimulation of the parasympathetic vagus nerve and that of calcium simulates the stimulation of the sympathetic.

Further investigation in this field may reveal that the reaction of intraocular pressure to electric stimulation may have diagnostic and, perhaps, therapeutic significance.